EXPLORING THE TEACHING OF STATISTICS IN GRADE 10

By

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Dedication

This work is dedicated

To:

My late dad, **Robert Taylor,**

Who was the original source of my inspiration and motivation.

Acknowledgements

First and foremost, I would like to give thanks to God Almighty for keeping me alive, healthy and helping me through this dissertation especially during the times when I thought of giving up and tended to lose hope.

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My mathematics colleagues, in Umlazi and Ugu district, for being available to participate in my study and for so willingly supporting me throughout my study.

Declaration

I, Romano Graham Stephen Taylor, declare that this is my own work, submitted in fulfilment of the degree of Master of Education at the University of KwaZulu-Natal. I further declare that this dissertation has never been submitted at any other university or institution for any purpose, academic or otherwise.

Romano Graham Stephen Taylor

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Date: _____

As the candidate's supervisor I agree to the submission of this thesis/dissertation
Dr. Jayaluxmi Naidoo

_____

Date: _____

Preface

The work described in this thesis was carried out from January 2013 to December 2015 under the supervision of Dr J. Naidoo from the Mathematics and Computer Science Education Department, University of KwaZulu-Natal.

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any tertiary institution. Where use has been made of the work of others, it is duly acknowledged in the text.

Abbreviations and Acronyms

Abbreviation	Description
AMESA	Association for Mathematics Education of South Africa
ANA	Annual National Assessment
B.Ed.	Bachelor of Education
CAPS	Curriculum Assessment Policy Statement
C2005	Curriculum 2005
DBE	Department of Basic Education
DoE	Department of Education
FET	Further Education and Training
HOD	Head of Department
GET	General Education and Training
LTSM	Learner Teacher Support Material
MKFT	Mathematical knowledge for Teaching
MLMMS	Mathematical Literacy, Mathematics and Mathematical Science
NCS	National Curriculum Statement
PCK	Pedagogical Content Knowledge
Stats SA	Statistics South Africa
SMTs	School Management Teams
UKZN	University of Kwa-Zulu Natal

Tables used in the study

Figures used in the study

Coding used in the study

Grade 10 Mathematics teachers' questionnaires, observations and interviews

Teacher	Questionnaire code	Observation code	Interview code
Sam	SQ	SO	SI
Nana	NQ	NO	NI
Mary	MQ	MO	MI
Zack	ZQ	ZO	ZI
Pat	PQ	PO	PI
Rodney	RQ	RO	RI
Ben	BQ	BO	BI

Participants' schools

Teacher	School	Code
Sam	**Mango Secondary**	**Mov**
Nana	**Apple Secondary**	**Aov**
Mary	**Lemon secondary**	**Lov**
Zack	**Banana Secondary**	**Bov**
Pat	**Peach Secondary**	**Pov**
Rodney	**Grape Secondary**	**Gov**
Ben	**Watermelon Secondary**	**Wov**

Key

Examples of the coding used in this study are illustrated below.

Example:

PI- Pat Interview

ZO- Zack Observation

BQ- Ben Questionnaire

Mov- Mango Secondary observation visit

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Abstract

The purpose of the study was to explore the teaching of statistics at Grade 10 level. A convenient sample of seven Grade 10 mathematics teachers participated in the study. The Department of Basic Education (DBE) has tried and is still trying to implement innovations and strategies for teaching mathematics more effectively. The South African education sector has experienced many changes in the mathematics curriculum with the aim of placing the country on an equal footing globally. Teachers are guided to teach a common curriculum so that all learners have equal understanding and opportunities in achieving success in any chosen field beyond schooling. This study was conducted while the new Curriculum and Assessment Policy Statement (CAPS) was already in place.

This study was guided by a qualitative method within an interpretive paradigm. The data was collected from the teachers via a teacher questionnaire, classroom observation schedule and semi- structured interviews. The validity and reliability of all these instruments was established. Teacher interviews were transcribed and classified according to themes. Classroom observations were analysed by using themes and checking for similarities and differences.

The findings suggest that teachers used innovative teaching methods irrespective of the teaching context. These methods were used to reiterate the content and concepts used in the teaching process. The results of the study found that the possible ways to improve the teaching of statistics in Grade 10 are: teachers should receive support from their schools/districts to attend in-service education and training programmes, textbooks should be well structured and contain all the information necessary to teach statistics and in-service teacher programmes should meet the needs of teachers by offering content knowledge and longer in- service programmes on the topic of statistics.

CHAPTER 1
INTRODUCTION

1.1 Introduction

The quality of teaching in South Africa has been a concern for teachers and the communities for a long time. This study has been conducted during the period of implementation of the Curriculum and Assessment Policy Statement (CAPS) Grade 10-12 Mathematics for the Further Education and Training phase (DoBE, 2011). This study aims to explore the teaching of statistics at Grade 10 level. The participants of this study were seven teachers who were teaching mathematics in the Further Education and Training phase, more specifically, Grade 10. This chapter gives an outline of the study, where the motivation to embark on this research is discussed and the research questions are introduced.

1.2. Motivation for the Study

The curriculum in secondary schools in South Africa is structured in such a way that learners have a choice in respect of doing mathematics or mathematical literacy as a subject in the Further Education and Training (FET) Phase, which is made up of Grade 10 to Grade 12. According to Khuzwayo (2005**)** the introduction of a democratic government in South Africa has been accompanied by a reform in the education system. Since 1994, there have been many curriculum changes in South Africa. The new government in the democratic era aims to eradicate the imbalances of the apartheid government. In all the changes in policies, education has had the most changes and currently, a curriculum called CAPS has been introduced.

The importance of the mathematics curriculum cannot be over-emphasised. The current mathematics curriculum was introduced with the rationale that it would help learners use it as a tool in solving problems related to the real world (DoE, 2003). Such perceptions were linked to a great demand in South Africa to compete on a global level. Consequently, there is hope that the current mathematics curriculum will put South African mathematics education on a level that can be competitive with other countries. Furthermore, the idea is that the current mathematics curriculum can enable the majority of learners to enter extended fields of mathematical sciences and the various career paths that this would facilitate.

One notable change in the curriculum was the introduction of Statistics (Data handling) in Mathematical Literacy, Mathematics and Mathematical Science (MLMMS) in the General Education and Training (GET) phase. With changes in the school curriculum in South Africa, statistics has been incorporated as core content in the further Education and Training (FET) phase mathematics curriculum. When the C2005 curriculum was reviewed and later replaced with the National Curriculum Statement (NCS), statistics was also introduced in the Further Education and Training (FET) Mathematics. This was the first time that statistics was part of the school curriculum. Mathematics for the FET band is regarded as a gateway for learners to pursue careers related to economics, management and social sciences (DoE, 2003). Solving mathematical problems is also viewed as a way of enabling learners to understand the world with its different challenges which impact on their lives. It is vital that schools in the FET phase be well- resourced with sufficiently qualified mathematics teachers in order for learners to make sense of the current mathematics. Teachers are expected to establish an integration of mathematics as a discipline as well as the application of mathematics in the real world context (DoE, 2003).

While not ignoring the benefits of including statistics as a core component of the mathematics curriculum, there are some challenges that are experienced by teachers. These include some teachers not having sufficient content knowledge or pedagogical content knowledge to teach statistics in ways that will promote and enhance the learning of statistics amongst FET learners. According to Wessels (2008, p.21) due to "a lack of content knowledge and knowledge of how learners develop and understand statistical concepts, however, teachers are not yet fully prepared to implement the intended curriculum". Batanero, Burrill & Chris (2011) claim that it is evident from the experiences of teachers teaching statistics worldwide, that a majority of teachers are not well equipped to teach statistics. Hence, the topic under consideration is quite important for the development of better teaching of statistics. Therefore, according to Wessels (2008, p.22) many mathematics teachers in South Africa are not yet statistically literate and lack confidence to teach statistics, more professional development initiatives are needed to prepare them to implement the curriculum successfully. According to Zewotir & North (2011) empowering teachers to teach statistics is significant to further the improvement of statistics education at all levels.

Hellar and Mnyanyi (2008) describe teaching as a process of imparting knowledge, the development of skills, attitudes and values, meeting needs in particular ways ranging from

structured to individualised activities with instructional tools which support and enrich the teaching and learning process. According to Smith (2016) teaching is imparting knowledge and skill, where teaching is that which results in learning and undertaking certain tasks or activities with the intention to initiate learning. Teaching can be using what learners think in preparing them for independent action. Teaching is an action which carries out activities that experience shows to be effective in enabling learners to learn. Teaching should allow for a challenging curriculum to be taught with understanding in a meaningful context in order to apply academic learning to important real world problems so that learners see meaning and purpose in their learning. According to Hellar and Mnyanyi (2008) the main goal of a teaching method is to develop an ability to enhance active participation, creativity, critical thinking, interest and a positive attitude towards learning. A teacher is expected to develop ability to explore learners' prior knowledge of the concepts and plan practical activities to develop understanding. Prior knowledge of the learner is one of the main resources in the teaching process. Within this study the teachers used innovative teaching methods through the use of different instructional tools such as the chalkboard, textbook, worksheets and power point presentations.

The South African mathematics curriculum has introduced statistics as a section in the mathematics curriculum to inspire learners to become statistically literate and allow them to interact with day -to -day encounters as they grow into adulthood, becoming responsible citizens. Garfield and Ben-Zvi (2008) view statistics as a section in the mathematics curriculum that enables learners to become aware of the way statisticians communicate information to citizens together with the rest of the world in the form of statistical reports. Statistics provides learners with knowledge to think critically and make sound judgements based on the information they acquire and with which they are presented. Information in the form of data has become the driving force in the era in which we live, therefore we are living in a data driven society which requires statistically informed citizens. Being statistically literate is a great advantage to any individuals' decision making process of life. As a researcher I am interested in the teaching of statistics, focusing specifically on the Further Education and Training phase (FET) where the learners are reaching their exit point of their schooling lives. At this stage the learners are being groomed and prepared for adulthood in becoming citizens of the country as well as future leaders. This serves to be the best platform to conduct my study. Hence, the purpose of this study is to explore how statistics is taught at Grade 10 level.

This study took place in the Durban South Region of KwaZulu-Natal where seven different schools were purposefully chosen to participate in the study. Before 1994, education in South Africa was segregated according to the different race groups; therefore there was an unequal distribution of funding, resources and access to education. However, the location chosen to conduct the study has easy accessibility to the diverse schools that were previously segregated according to different race groups, gender, and economic class. Furthermore, there exists an imbalance of resources in the teaching and learning process within these different schools resulting from the inequality in the distribution of funding in the past. Moreover, this inequality has led to an imbalance in the quality of education. It is now twenty years of democracy with minimal change being visible, especially in education, considering that most of the country's budget is being allocated to education. Democracy came with many changes, especially in the education sector. I wish to place particular focus on the mathematics curriculum and the introduction of statistics which was done to assist learners for the future, including the country's needs as a whole.

Hence, I wish to explore the teaching of statistics at Grade 10 level in the mathematics curriculum in order to determine the aim of the study pertaining to the teaching of statistics at Grade 10 level and whether statistics should be taught at school level since it can be applied in daily life. Statistics plays a crucial role within other disciplines and is important in the development of critical reasoning and understanding in many professions. The rationale to introduce statistics at school level would be to equip learners with basic statistical skills to appreciate the value of statistics in their professional and personal lives. It empowers learners to evaluate practices and draw informed conclusions when they encounter data. Statistics instils a discipline of alertness, creating an ability to analyse, process and evaluate data. It inculcates innovative thinking in the learner and it questions normal processes.

Statistics empowers learners on a personal and professional basis. On a personal basis, a learner who has an interest in a sporting world, for example, cricket, is able to calculate and determine a batsman's batting average or a bowler's economy rate. This also assists a learner in enjoying the sport better, the more they are able to understand their favourite players' ability statistically. On a professional basis, each profession makes use of statistics. In production there is a head count in comparison to work being processed. In the medical field statistics is used in research and data analysis of medicine allocations. The focus should be on data collection, analysis, interpretation, presentation and organisation and also be on the

application of statistics to scientific, industrial or social issues. Statistics influences the learners' thought patterns, broadens their knowledge and allows learners to form an opinion on certain aspects.

1.3 Rationale for the study

The current mathematics curriculum was inspired and informed by curriculum developments that have taken place in many other countries. Chisholm, Volmink, Ndhlovu, Potenza, Mahomed, Muller (2000) claim that the curriculum was intended to catapult South Africa into the 21st century. According to Zewotir & North (2011) the new curriculum places emphasis on moving from the traditional aims and objectives approach as a prerequisite to achieve the vision of an international competitive country. The aim of the Curriculum Assessment Policy Statement for mathematics tries to reduce the gap between the rich and poor learners in achievement in mathematics, to reduce inequality in mathematics achievement. In a report by the Minister of Basic Education, Mrs Angie Motshekga's statement (DoE, 2010) the National Curriculum Statement is being amended in order to strengthen and improve the quality of teaching and learning in schools. Workshops were conducted before the implementation of the curriculum with the aim of preparing Grade 10 teachers and FET mathematics teachers in order for successful implementation of the curriculum. Schools and teachers were provided with CAPS policy documents in preparation for the current curriculum. But the workshops provided were one day workshops and one teacher per school, eliminating the majority of mathematics teachers who would be implementing the curriculum. The idea was that the teachers who attended the workshop will cascade the information to the rest of the mathematics teachers in the school as the documents provided at the workshops contained all the information needed in detail. In the workshops, teachers were also provided with hand-outs, to supplement the official policy documents. The supplemented documents assisted in the unpacking of the content contained in the policy documents. The Department of Education promised that by 2012, all schools would be ready for the implementation of the curriculum for the first time in Grade 10. As a mathematics teacher working in urban schools for almost ten years, I have developed an interest in exploring teachers' teaching practices and understanding of statistics taught within the mathematics curriculum.

Once the curriculum was in place, it was assumed that all schools offering the curriculum were ready to implement it. The evidence for this is that there was no monitoring done by the

department officials at the schools, except that exemplar question papers were sent to schools towards the end of the year in 2013. According to Moodley (2013) CAPS was introduced with the aim of improving teaching and learning, however with the implementation of any new curriculum the following is expected: teacher training is required, a need for new resources and an increased workload. The obstacles and challenges encountered by schools and mathematics teachers in implementing the curriculum, particularly in Grade 10 were not attended to. Curriculum implementation challenges and difficulties need to be dealt with quickly and efficiently when they are established according to Motshekga statement (DoE, 2010). However, the support for mathematics teachers continued to be enjoyed by Grade 12 teachers, particularly in well performing schools. As a researcher based in an urban school, I attest to the fact that urban schools are minimally supported in terms of teacher support, accessing resources and the upgrading of school buildings and human resources. It is crucial that research needs to be done in this field in order to explore teachers' understanding and practices of CAPS Grade 10 mathematics, particularly in the Durban south schools.

1.4 Focus of the study

Although the current mathematics syllabus has been in place for Grade 10 for approximately three years, it is important to conduct research in this field with the aim of determining teachers' understanding and practices in teaching the Grade 10 mathematics curriculum in particular the topic statistics in the diverse schools. This study was conducted in seven secondary schools, located in the Durban South Region in KwaZulu-Natal. While the seven schools have electricity, the majority have poor building infrastructure and are lacking in resources. The study was set to explore the teaching of statistics at Grade 10 level. In the new CAPS for Grades 10 – 12, which was implemented in 2012, mathematics is divided into two papers, Paper 1 and Paper 2, with Paper 2 incorporating statistics.

1.5 Research Questions

To accomplish the purpose of the study three critical questions were developed in guiding the study. The questions are as follows:

1. What methods do teachers use when teaching statistics in Grade 10?
2. How is statistics taught in Grade 10?
3. Why are these methods being used by teachers when teaching statistics in Grade 10?

1.6 Significance of the study

This study highlights the innovative teaching methods and the different instructional tools used to teach statistics at the Grade 10 level and its significance in the real world. The study aims at gaining insight on the methods and instructional tools in which the statistics content is delivered at school level and the methods and the examples used by teachers to impart the knowledge to the learners. Effective teaching in mathematics particularly statistics, requires an understanding of what learners and teachers know and what learners need to know. Teachers ought to be able to establish what learners understand and what knowledge learners need to understand with respect to mathematics content knowledge. It assists people in understanding how statistics is being taught in schools. According to Naidoo (2011) teaching does not mean standing in front of the class and imparting knowledge; rather, teaching is the ability to find the perfect strategies and methods to ensure that effective teaching takes place.

The study will assist the mathematics community with an interest in the different methods and instructional tools to teach statistics at Grade 10 level. The study draws awareness to the understanding of the importance of statistics thinking, teaching, learning and the use of this understanding in relation to the real world.

1.7 Organisation of the study

The report is divided into seven chapters which are divided into several sections and subsections. The following is a short description of what is contained in each chapter.

Chapter 1: Introduction

This chapter introduces the study by giving a brief background of the study. The purpose and rationale for the study are provided. Finally, it provides the critical research questions of the study and brief descriptions of each chapter contained in this study report.

Chapter 2: Literature Review

This chapter contains the review of the literature relating to mathematics in general, the teaching of mathematics, teaching methods used in mathematics, statistics in mathematics, the teaching of statistics and the teaching methods used in statistics within the mathematics curriculum in the FET band.

Chapter 3: Theoretical Framework

This chapter presents the theoretical framework of the study, since the study is framed using two theories: Social Constructionism and the theory of Teacher Knowledge, more specifically pedagogical content knowledge. It includes their description, relationship to the teaching of statistics and theories in relation to the study and a conclusion.

Chapter 4: Methodology

This chapter sets the stage for the research methodology and therefore consists of an introduction, the research method, the research design, pilot study, methods of data analysis, ethical considerations and a conclusion. The development of materials and processes undertaken to improve on the reliability of results and the different data collection tools used are discussed in depth.

Chapter 5: Data Analysis

This chapter presents the results as they emerged from the data collected. Teachers' information from the questionnaire and the nature of teachers' classroom practice from the observations and interviews are also presented with the analysis of the data that was collected from the field.

Chapter 6: Findings and Recommendations

This chapter gives a systematic process of the findings and recommendations from the study. The critical questions that guided this study are answered based on the findings and support from literature. This chapter deals with the summary of the research, recommendations and conclusions based on teachers' methods of teaching statistics at the Grade 10 level. The last section presents recommendations to teachers, school management teams and recommendations based on the findings, and some concluding remarks of the research study.

Chapter 7: Conclusion

This final chapter presents the conclusion based on how Grade 10 mathematics teachers teach statistics, the main findings of the study, the methodological approach, implications of the study, limitations of the study and a conclusion based on the study.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The main purpose of this study is to explore the teaching of statistics at Grade 10 level. Teaching should encompass two processes, a process in directing learners to the knowledge needed and challenging them to partake in thinking about concepts to construct in their minds. These processes are required in order to teach learners to become fully functional thinkers. Teaching is not just moulding a learner; it is a whole combination of guidance skills. But more precisely has to be about inspiring learners to think well. Statistics is taught within the mathematics curriculum as an individual topic in school mathematics; however the topic statistics, according to Gravemeijer (1994) is introduced into the mathematics curriculum to accomplish new goals. In order to understand the importance of statistics in mathematics, it is important to understand and have a clear view of what mathematics is. The Department of Basic Education (2011, p.11) views "mathematics as a language that makes use of symbols and notations to describe numerical, geometric and graphical relationships, it is a human activity that involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena between mathematical objects themselves". Similarly, Davis & Hersh (2005) views mathematics as a human activity. According to the Department of Education (2011, p.11), "It helps to develop mental processes that enhance logical and critical thinking, accuracy and problem solving that will attribute in decision making". In this chapter I wish to discuss the literature around mathematics in general, the teaching of mathematics, the teaching methods used to teach mathematics, statistics in mathematics, the teaching of statistics as well as the teaching methods used to teach statistics.

2.2 Mathematics in general

Mathematics is concerned with the study of measurement, properties, relationships of quantities, sets, symbols, numbers, geometric objects, theories and theorems and many other mathematical concepts. Mathematics is indefinable and has no precise definition but, according to Ziegler (2011), it is a subject that possesses knowledge that can be studied and learnt. According to Courant and Robbins (1996) mathematics can be an expression of the human mind which is useful to daily living. Ziegler (2011) claims that through logical

reasoning in mathematics, abstract thinking has developed concepts such as counting, calculation, measurement and the study of shapes as mathematics is a human activity.

This implies that mathematics is essential in everyday life. Davis & Hersh (2005) is of the opinion that mathematics is a human activity which is part of the human culture and carried out in everyday experiences. Mathematics can be described as a discipline created by human beings to enable one to think in a more logical manner. This confirms that human beings continuously practice mathematics on a daily basis. Brown (2010) also views mathematics as the structure of life to produce entities in unique ways.

Human beings are in need of mathematics in order to survive as it is used on a daily basis and governs the way people live. Human beings constantly rely on mathematics on a daily basis from morning to evening, with daily activities continuously governed and directed by the use of mathematics. From the time one awakes for the new day, start work, have lunch and tea breaks, to the time one finishes work until one goes to sleep, mathematics has become part of our lives; people have become dependent on mathematics for their day to day functioning. Gutstein, Fey, Heid, Delaoch –Johnson, Middleton, Larson, Dougherty and Tunis (2005) are of the view that mathematics has a significant role in the decision making that moulds the day to day work of a school, classroom, teachers, policy makers and other career paths. It provides direction in the actions we take on a daily basis with special focus on education. This demonstrates the important role of mathematics in our day to day living. Brown (2010) elaborates further by claiming that mathematics can be a two way road for learners where they are learning mathematics in the present culture and also simultaneously learning through experimentation to access the truth. According to Sierpinska, Kilpatrick, Balacheff, Howson, Sfard & Steinbring (1993) mathematics education is described as being the teaching and learning of mathematics, the aim being to improve the teaching of mathematics and simultaneously improving learners' understanding and performance. Goffree (1993) is of the view that the precise aim of mathematics education is to teach mathematics. According to Barnes (2005) mathematics is a human activity that involves observing, representing and Investigating patterns

Being familiar with mathematics has been regarded as a significant part of the intellectual component of every cultured individual. Understanding mathematics gives value to humans and the context in which they live. The teaching and learning of mathematics that is taking

place in most classrooms is still rote memorisation, whereby learners learn what is required to pass an examination. Similarly, teachers educate the learners on what is required in order to progress in a particular examination or assessment, leading to the outcome being satisfactory and no real understanding achieved, with no intellectual independence being gained. The drive of teaching and learning mathematics is teaching and learning for understanding. Based on anecdotal evidence, learners are required to memorise formulae in Grade 10 and 11 common tests and it is only in Grade 12 that learners are provided with a formula or data sheet. Mathematics is used throughout the world as an essential tool for basic everyday living, making mathematics a basic instrument in daily encounters.

It has been discovered by many researchers that mathematics is a human activity. Gravemeijer (1994) sees mathematics as an activity of actually doing mathematics; it however involves engaging with the content within mathematics. Brown (2010) is mindful that mathematics in school is presented in different forms from country to country. Ziegler (2011) explains further that mathematics is concerned with the application of mathematical thinking to other fields, allowing for new mathematics discoveries which have led to the development of entirely new mathematics disciplines such as statistics. Therefore mathematical ideas and concepts are used as a foundation to achieve the outcomes of such disciplines.

Mathematics has been extensively extended with fruitful interaction between mathematics and science. Mathematics, according to Courant and Robbins (1996), is not only used within itself but lends itself to other disciplines such as business, science and agriculture. This provides a clear indication of the diversity of mathematics and emphasising that mathematics does not work in isolation but rather integrates itself with many other aspects of life and disciplines. Goulding (2004) claims mathematics is vital in everyday life since many forms of employment, science, technology, medicine, the economy, the environment and development in public decision making make use of the logical reasoning acquired in mathematics. With the absence of mathematics logical reasoning and thinking is not easily achievable, therefore skills acquired in mathematics lead to logical reasoning, thinking and decision making. In the past mathematics was merely known to be just basic mathematics with no distinction between pure mathematics and applied mathematics. Mathematics, according to Courant and Robbins (1996) has presently been formally constructed and used practically by humans to identify the use of mathematics in everyday living and being part of human activity. In addition Dörfler

(2003) believes that there is a relationship between mathematics and human beings, as mathematics is a human activity which deals with actual living human beings. Therefore mathematics is in demand and highly useful in daily living**.**

2.3 Teaching of mathematics

Nickson (2000) claims the teaching of mathematics has its roots in the classroom precisely where actual teaching and learning takes place. Dörfler (2003) describes mathematics education as being primarily concerned with actual and living human beings who utilise its concepts. It has to pay attention to the needs, wishes, anxieties, expectations and feelings of people, for example learners, teachers and researchers. According to Goulding (2004) mathematics in conjunction with mathematics teaching is purely driven by social and political factors in which it is embedded. The teaching and learning of mathematics is controlled socially, politically and economically and also utiilsed to achieve the outcomes of these sectors in order to mould our learners for their needs. The social and political sector has a huge influence on what is to be taught in mathematics. According to Flores (2005) when societal expectations, political and social priorities change, they make new demands on schools and teachers. Amimo (2009) claims that it is impossible to have a perfect curriculum for all generations as the environment continuously changes and creates new needs within society. The curriculum changes continuously in order to address the needs of the present generation. This brings about the introduction of new topics within the curriculum to cater for the new changes.

In the view of Nickson (2000), the majority of mathematics teachers believe that mathematics as a subject has an important influence in the lives of learners at all levels. Mathematics can be very useful at almost every basic level of any individual's life including jobs which require the use of mathematics. According to Dörfler (2003), teaching mathematics and incorporating everyday examples provides more value to the teaching and learning of mathematics. According to Goulding (2004) mathematics is part of our history; it is useful in other disciplines and can be used as a benchmark for entry at certain courses and careers. Hence, mathematics education is the driving force of the teaching and learning of mathematics. Cantoral and Farfaan (2003, p. 256) claim "mathematics education is a discipline of knowledge". Dörfler (2003) claims that mathematics teachers ought to be equipped to teach mathematics at all levels at school. Cantoral and Farfaan (2003) continue to affirm that teachers need to be trained continuously since education is changing.

Furthermore, according to Naidoo (2011) teaching mathematics has been a challenge to most teachers which is indicated by the lower pass rate over the past years. Teachers who are teaching mathematics should be provided with continuous support from all the various stakeholders involved such as subject heads, heads of department, school management teams and subject advisors. Empowerment and teacher development are critical and significant processes, greatly enhancing the teaching and learning process. This allows for success in the teaching and learning of mathematics. Simon (2004) also feels that teacher development is essential in the teaching and learning of mathematics, where teachers are constantly empowered and kept up to date with current teaching methodologies including content knowledge. This is in support of the teacher's role in becoming a lifelong learner. Likewise, Asikainen, Pehkonen and Hirvonen (2013) explain that the quality of an individual teacher's own knowledge is related to the preparation of lessons, teaching and delivery of these lessons.

According to Krauss, Baumert and Blum (2008) there is a great demand for a teacher's knowledge to be an essential ingredient of high quality instruction with a particular focus on the mathematics classroom. Therefore content knowledge in the teaching of mathematics is significant. Teacher knowledge influences the quality of teaching and in turn, the quality of learning. However Asikainen, Pehkonen and Hirvonen (2013) recommend that mathematics teachers should understand the structure of mathematical knowledge and the theory of mathematics since it is the cornerstone of a mathematics teacher's knowledge base. According to Krauss, Baumert and Blum (2008) a teacher's knowledge, specifically content knowledge, influences the process of teaching and learning especially within a mathematics classroom. A teacher's knowledge contributes significantly to the teaching and learning of the mathematics curriculum. Cantoral and Farfaan (2003, p.266) claim that "studies are being presently developed in relation to curricula which seek to determine what the teaching content should be and mathematics as well as the social needs that the educational system hopes to address through schooling". Attention has been placed on resources especially those that reinforce the teaching process in the classroom such as educational materials, textbooks, calculators and computers. They seek to determine the influence that the school system has on learning with a particular focus on mathematics learning. According to Barnes (2005) mathematics is a product of investigation by different cultures with the purpose to fulfil the context of social, political and economic goals.

The fundamental aim of teaching mathematics is to equip learners with the strategies, skills, knowledge and most significantly the confidence to use their mathematics to solve problems that they will encounter throughout their lives (DoE, 2002). Barnes (2005) claims that the teaching and learning of mathematics should enable the learner to develop an awareness of the diverse historical, cultural and social practices of mathematics. Understand that mathematics is a creative part of human activities and to gain specific knowledge and skills necessary for the application of mathematics to physical, social and mathematical problems.

Teachers of mathematics ought to ensure that their teaching is meaningful. According to Ediger (2002) the use of examples that are related to everyday life are vital in the teaching of mathematics. A register for example is marked on a daily basis for learners present and absent, together with the total number enrolled. The use of numbers and statistics in the computation is applied. According to Raudenbush (2005) the primary concern of mathematics researchers is the tools, methods and approaches that are used in the teaching of mathematics. According to Vithal (2012, p. 45) "the challenge in mathematics education is finding the best way to teach mathematics, learners need to know mathematics before they can apply it". Teachers are confronted with numerous challenges when teaching mathematics. It is necessary to teach sufficient amounts of modern mathematics to learners within the current school mathematics curriculum. This is an applicable and presently applied idea in the current South African school mathematics curriculum.

With the present CAPS curriculum that has been introduced there is a great concern with the large amount of content that has to be taught and learnt within the mathematics curriculum. However, Goffree (1993) is of the belief that teaching mathematics is an activity that enables organisation when planned appropriately. Gravemeijer (1994) further views organisation within the mathematics curriculum significant for the benefit of effective learning to take place.

The South African mathematics curriculum has changed several times in conjunction with the change of government. Any new curriculum is introduced with the aim of changing the organisation of education to introduce new ideas, goals and content. Brown (2010) states that depending on a particular curriculum and its emphasis on the skills that are required will determine the teaching styles. According to Gravemeijer (1994) to teach an established and existing curriculum with new ideas and outcomes will determine the teaching styles.

Amongst many other challenges that are encountered within the mathematics teaching is gender equity. According to Levi (2000) gender equity in mathematics teaching is a very complex issue with society having a tendency to value the activities males engage in as opposed to females.

Another challenge faced in mathematics teaching is to be accountable for your teaching in the form of results. Many secondary school teachers still encounter learners who have had very few opportunities to learn and think mathematically. According to Adler and Davis (2006) teachers have to deal with what learners know and what the curriculum expects at the level at which they are teaching. When a learner displays understanding of what has been taught thereafter the teacher is in a position to evaluate whether their teaching has been successful or not. This challenge is due to cultural differences as well as curriculum reform with special reference to South Africa. Within the South African context, according to Adler and Davis (2006), the reform and transformation has much to do with redress and repair of the apartheid regime. The redress comes from the past training of teachers, in situations where their training was dependent on their race group. According to Bansilal (2014, p.42) "one of the anomalies of apartheid education was the variation in the teacher preparation among the different races". This gave rise to inequality of education and oppression amongst the different races and genders.

Currently the training of all teachers is afforded an equal chance and opportunity within the democratic society to all races. According to Adler and Davis (2006, p.277) "A graduate in the Bachelor of Education (B.Ed.) program who graduates to teach secondary school mathematics in South Africa needs to have developed a strong sense of himself or herself , as a teacher within this moral order and as a mathematics teacher must be able to promote democratic values". With this in mind a mathematics teacher has to face these situations at school and within the classroom. Based on my anecdotal experience this is evident in the new democratic South African classroom. This reform and redress has led to mathematics teachers not receiving adequate opportunity to learn further mathematics.

Due to the diverse culture inherited by the present generation within the South African context, the use of different languages in the teaching process is encouraged which is referred to as code switching. Similarly, Barwell, Barton and Setati (2007) have a view that mathematics is a language on its own and therefore it is important to use multilingualism and

bilingualism in mathematics classrooms. Caraher, Anulucia and Schliemann (2002) recommend that a diversified background is the most beneficial kind of preparation that schools can provide to learners. According to Barwell, Barton and Setati (2007), an increased amount on work related to mathematics teaching and learning in multilingual classrooms is being done. Multilingualism is practiced in mathematics classrooms in order to ensure and emphasise understanding. Using a language that one understands makes the learning and teaching of mathematics less complicated. The teacher and the learner are able to communicate therefore there should be success achieved in the teaching and learning process.

However, sometimes it is not positive in that teachers end up focusing on the language as opposed to the teaching of mathematics. Caraher, Anulucia and Schliemann (2002) raise the concern that schools encourage a repetitive practice. Concerning the teaching of mathematics at school, the goals are different to what are expected at tertiary level. It is difficult to be able to cater for every individual's needs at school level as learners take diverse options after secondary schooling into tertiary education. The schooling system is unable to provide and satisfy all the learners together with all their diverse options. In the 21st century the teaching of mathematics is more focused on mathematical method, understanding and teaching towards the use of mathematics in the real world. Unlike previously mathematics focused on rote learning and achievement, eliminating understanding and utilization of the content and method learnt for future use. The methods used to teach mathematics aim to motivate learners to learn mathematics in order to transfer this knowledge into their daily lives and future careers. Vithal (2012) explains that mathematics should revolve around problem solving. We can use mathematics to solve problems and learn the mathematics needed to solve problems.

There is an implication that mathematics is not interesting unless it is attached to something interesting in the real world. So if an interest is attached to the subject then it will be a subject which will be interesting to learn. In the view of Ediger (2002) learners have different ways of learning, for example, if a teacher teaches too fast some learners may not grasp the concept. Similarly, if a teacher teaches at a slow pace then boredom sets in. Learners need to be motivated to interact with the content being taught and familiar examples are to be used. The introduction of technological resources needs to be incorporated within the learning process. According to Krauss, Baumert and Blum (2008) a teacher's content knowledge influences the process of teaching within a mathematics classroom. Ediger (2002) suggests that focus needs to be placed on the involvement of learners instead of just informing the

learners. Learners must be allowed to go out and research so that they are involved and participate in their learning. Therefore interaction amongst learners needs to be encouraged so that different ideas and thinking may be circulated amongst them.

Teachers need to be well equipped when teaching a lesson in order to explain facts, concepts and procedures clearly in the most appropriate way. Teachers need to be well equipped and prepared in the content knowledge in order to be able to explain what is unclear to learners. Therefore mathematics teachers should learn from their experience, the rules of thinking before they enter the classroom. Well prepared teachers will provide effective teaching for their learners. Teachers are the tools in developing a positive attitude from learner to mathematics and as attitudes are learnt therefore they can also be taught. All learners have capabilities to perform well in mathematics provided their mindset and attitude are well conditioned.

In some secondary schools, learners are not being adequately prepared for the real world and real mathematics in that learners are given all the information by the teachers. Based on anecdotal evidence and as a practicing mathematics teacher I have observed that teachers make the assumption that the problems are difficult for the learners. Mhlolo, Venkat and Schafar (2012) state that developing countries like South Africa have revised their mathematics curriculum in recent years taking into account what they expect their learners to know in the 21st century. The level of pass rates may have increased in mathematics but the standard has decreased. Based on anecdotal evidence as a practicing mathematics teacher, the required standard to progress has been lowered from previous years.

The methods of teaching mathematics vary in conjunction with the changing objectives and curricula changes. Teachers can set expectations, time, and kinds of activities, questions, acceptable answers and the discussions that will influence the learners' opportunity to learn. This should involve both skill efficiency and conceptual understanding. The reinforcement of mathematical skills is achieved through engaging and completing numerous exercises of a similar type, such as handling vulgar fractions or solving quadratic equations or dealing with data in the case of statistics. The cultivation of mathematical thinking could be achieved by setting learners open ended and unusual problems and questions. The use of everyday problems in the classroom relating to the topic being taught, using current events increases the enthusiasm and understanding for the learners. Mathematical problems that are fun and

meaningful can motivate learners to learn mathematics and can increase their enjoyment of mathematics. Computer based mathematics can be, according to Smith (2004), an approach focused on the use of mathematical software as a primary tool of computation.

Miller (2004) derived four basic principles that may assist teachers to stay on the right track with the teaching of mathematics. The four basic principles include making sense by striving to teach to ensure mathematical concepts and procedures are understood and why something works, not only how it works. The recalling of the set goals to connect with their sub goals will enable them to become better teachers. Tool knowledge should be well known to the teacher which is books, black or white board, protractors, computer software and calculators. When teachers display love and joy for mathematics learners become encouraged and develop a positive attitude towards mathematics.

2.4 Teaching methods used in mathematics

There is a variety of methods used to teach mathematics. According to McTighe and Seif (2003) teachers should create situations in which learners ask questions, develop strategies for solving problems and communicate with one another. Learners are often expected to explain their answers and discuss how they arrived at their conclusions. Teaching should allow for a challenging curriculum to be taught with understanding in a meaningful context in order to apply academic learning to important real world problems so that learners see meaning and purpose in their studies. According to Damandodran and Rengarajan (2012) teaching should include two major components which are sending and receiving information. The teacher imparts knowledge the way he or she understands it. This can be achieved by using the following commonly used methods, brainstorming, discussion, demonstration, lecture or presentation and independent study.

2.4.1 Brainstorming

It is a process for generating multiple ideas in which conclusions are put on hold until numerous inputs have been generated. This method actively involves learners in high levels of thinking and encourages peer learning and critical thinking. It also promotes thinking, creativity, enquiry and agreement.

2.4.2 Discussion

Discussions take place when learners exchange points of view whilst engaging in a problem solving process. It enhances peer group learning, assists learners explore pre-existing

information and builds on what they know, facilitates sharing of ideas and awareness of mutual concerns and promoting the development of critical thinking.

2.4.3 Demonstration

It is a process of performing an activity in order for learners to observe how it is done and helps prepare learners to transfer theory to practical application. It assists learners who learn from modelling others, encourages self-confidence, creates opportunity for targeted questions and answers and allows attention to be focused on specific details rather than general theories. It takes proper and careful preparation to keep the demonstration simple and basic with the explanation being thorough enough to meet the objective and provides learners with the opportunity and chance to practice what has been demonstrated.

2.4.4 Lecture or presentation

It is precisely presentation of information, usually to a large group and often using audio visual aids to transmit the information. It can be an effective method of providing new information and clarifying existing information to a large group in a short period of time and can also be a good means to set the stage and lay the necessary groundwork and parameters for a subsequent activity. It should also encourage the learners' interest in future studies. It can also develop a solid introduction, body and conclusion and demonstrate effective presentation skills, including gestures, posture, and tone of voice, making eye contact and avoiding distracting behaviours. Time management is maintained to allow for questions and then the planned conclusion.

2.4.5 Independent study

It is designed to promote and support other instructional activities. Learning activity is typically done entirely by the individual learner using resource materials or using computer based technology. It fosters independent learning skills, allows learners to progress at their own rate and provides opportunity for learners to obtain prerequisite knowledge and is flexible, promotes individual schedules and is self-pacing.

2.5 Statistics in mathematics

In the view of Nickson (2000), statistics brings together a variety of ideas and concepts of mathematics that brings about meaningful learning to learners. Statistics however provides an allowance for learners to use mathematics in analysing data. Mathematics, according to

Scheafter and Emesitur (2004), is an essential tool for the teaching of statistics. Statistics has been placed as a topic within the subject mathematics even beyond schooling. Therefore statistics has settled in the mathematics curriculum with statistics being a sub topic within mathematics. According to Gattuso (2006) there is a close relationship between the teaching of statistics and the teaching of mathematics. Graham (2006, p.220) claims that "mathematics and statistics share certain features including the use of measurement, numbers, calculations and drawing of graphs". According to Nicholson, Rigway and McCusker (2013), statistics and mathematics possess similar concepts and ideas where statistics is generally a topic taught within mathematics in the South African mathematics curriculum. In the South African mathematics school curriculum statistics is not taught as a subject on its own but as an integral part of the mathematics curriculum. Statistics, according to North, Scheiber and Ottaviani (2010), has been placed in the mathematics curriculum to ensure that the grounding knowledge of statistics is embedded. Scheafter and Emesitur (2004) further describe statistics as numbers in context which are normally referred to as data. Statistics is made up of data in the form of numbers; this outlines the commonality between statistics and mathematics. This data can be interpreted and analysed in order to make sense of real world processes which require statistical knowledge, understanding and analyses.

Emphasis, according to Garfield and Ben-Zvi (2008), is placed on statistics in order to improve the level of statistical literacy and numeracy skills in learners in order to prepare learners for dealing with everyday situations that will require data analysis. Data plays a significant role in our present world. Rumsey (2002) claims statistics in the school mathematics curriculum raises awareness of data in everyday life**.** Garfield and Ben-Zvi (2008) further state that statistics provides learners with useful knowledge in order to intelligently interpret the information in the world around them. Statistics is part of mathematics, therefore the integration of statistics and mathematics allows for the teaching of statistics to become more meaningful in everyday life.

Furthermore the data learners encounter in everyday life becomes easier to understand and interpret when they are statistically literate. Therefore statistics has become necessary and an important area of study in the school mathematics curriculum because it involves powerful ways of thinking for learners enabling them to be statistically literate and empowered when it comes to dealing with data. Being statistically literate, according to Garfield and Ben-Zvi (2008), enables learners to make use of their mathematics learning to understand and interpret

real world messages that contain statistical information and knowledge. Statistics further enables learners to realise the interconnection of mathematics to their everyday living environment. It gives learners a clear view of the significance of mathematics and its use in statistics learning. The teaching of statistics within mathematics provides learners with tools for dealing with data within the data driven world in which we live.

One of the main differences between statistics and mathematics is statistics does not require precise answers; however, according to Nicholson and Mulhern (2000) the outcome has to have merit even though the answers may not be the same. Gattuso (2008) is also of the view that there is a difference in the reasoning between statistics and mathematics. The difference between statistics and mathematics is the reasoning and more precisely that mathematics requires more specific solutions, whereas statistics seeks for various solutions which come with merit. According to Nicholson and Mulhern (2000) the thinking required in mathematics and statistics is different. Similarly, Graham (2006) states there exists certain philosophical differences in the manner in which mathematicians and statisticians think, question and respond to questions. Gattuso (2008) elaborates that mathematics encourages methods more to the point and accurate solutions, yet statistics encourages a variety and creativity of the information provided in mathematics.

Scheafter and Emesitur (2004) point out that statistics has formed a home in the mathematics curriculum since teachers of mathematics have accepted the topic as part of the curriculum and are willing to teach it as part of mathematics. According to Reddy (2006) mathematics teaching at school level in South Africa lags behind many other countries. North, Scheiber and Ottaviani (2010) make known that the introduction of statistics in the South African mathematics curriculum has been introduced at a delayed pace¸ which has led to South Africa gaining from other countries. The delayed pace of introducing statistics enables South African citizens to overcome challenges that exist in the implementation of statistics within the mathematics curriculum. The introduction of statistics is vital and significant in our daily lives in modern society in the 21st century.

Statistics is often related to mathematics with the expectation that the focus will be on numbers, computations, formulae and precise answers because the basics of statistics are taught within the mathematics curriculum at school level. According to Qian (2011), there are still uncertainties whether or not statistics is a discipline on its own or a branch of

mathematics. However Scheafter and Emesitur (2004) view mathematics and statistics as two integrated disciplines that cannot be isolated as statistics needs numbers to be in existence where the numbers are used in the form of data and used to apply the concepts of statistics.

Gordon, Petocz and Reid (2009) claim that in the past the teaching of statistics focused on students training towards being professional statisticians as a topic in the mathematics department. According to Garfield and Ben-Zvi (2008), when learners encounter statistics they begin to panic and become uncomfortable with the messiness of data, especially if it is ungrouped data. Therefore mathematics is the basis of statistical knowledge and the concepts come from mathematics. According to Wessels (2008) the study of statistics should not merely rely on formulae but should enable learners to engage with examples and expressions from the real world. Gordon, Petocz and Reid (2009) propose that a good statistics learner needs a strong mathematical background and good thinking skills; mathematics has similarities to statistics since the data used is in the form of numbers and graphical representation. Statistics merely addresses questions based on the real world through the process of collecting and looking at data. According to Qian (2011) the variety of the use of statistics can be argued upon whether or not is it necessary because statistics is basically an application of mathematics nevertheless every discipline has its own concepts and approach regarding statistics. Statisticians are of the view that statistics is a discipline on its own due to its use in a variety of contexts and disciplines such as engineering, commerce and science.

Moore and Cobb (2000) describe statistics as a component of mathematics which deals with the measurement and description variability found amongst numbers of large populations. Bartholomew (1995) has a variety of ways in describing what statistics is, the main description is that the object of statistics is information and the objective of statistics is to understand the information contained in the data. The data is then used to draw conclusions based on its validity. According to Bailey (1998), in statistics real data is used as opposed to invented data because the aim of statistics is to provide appropriate methods of gathering data to obtain answers to specific questions and methods to draw conclusions from that particular data. According to Phillips, Basson and Botha (2011), statistics at school level involves the following, collecting data, sorting the data, representing the data graphically, interpreting results and making conclusions. Therefore, statistics is made up of five parts namely: deciding on what you want to find out and the questions you can ask, collecting the relevant data, organising the data, representing the data and interpret, analyse and report on the data.

This data is organised and interpreted to give a better understanding of the world around us. Mathematics is used to further this aim with the use of mathematical tools and instruments such as calculators and formulae with computers providing great help to statisticians. Moreover, according to Bailey (1998) statisticians benefit from mathematical ways of thinking and writing. According to North (2006) statistics enables one to make sense of the masses of information with which we are bombarded with daily. Statistics is within the mathematics curriculum to demonstrate the mathematics which is learnt has relevance in our day to day living. Therefore statisticians should appreciate and value mathematics since it involves mathematics and uses mathematical concepts, tools, and instruments, ways of writing, thinking and mathematics labels. This displays the significant role of mathematics in the topic statistics.

According to Bailey (1998) mathematicians have devised ways of writing and thinking for statisticians to benefit. Therefore the use of mathematics concepts makes data much simpler because statisticians write to communicate and this is guided by the use of mathematics. This means there is a relationship that exists between statistics and mathematics. According to Bartholomew (1995, p.13), "Mathematics sets a standard to which statistics should aspire, redefining statistics by saying statistics is a collective activity which must cope with the fact that no two individuals can be expected to have exactly the same perception of a situation". It has already been noted that statisticians write to communicate and our interpretation to that communication is never exactly the same. We need statisticians to broaden our perceptions since we depend on and have communication links and influences with the wider and real world. All events that occur are published in the statistical journals and the use of statistics has an influence to communicate to communities and the wider world, for example employments, unemployment, pass rates, traffic details, graduates and the sporting world and so on indicating that we live in a data driven world and society.

2.6 The teaching of statistics

According to Graham (2006) the aim for statistical education should not only focus on teaching a set of ideas and techniques. Instead learners should be assisted in developing a mindset for thinking more critically concerning the surroundings in which they live. The teaching of statistics is a new topic within the South African mathematics curriculum. In

previous years statistics within the South African school mathematics curriculum, according to Wessels (2008), was limited to where learners were given small organised data sets.

Burgess (2008) points out that statistics is young within the mathematics curriculum. According to researchers North and Zewitor (2006) learners learn using the formula based approach in secondary school statistics such as mean, median, mode, range, variance and standard deviation in statistics which has resulted in learners who were ill prepared for statistics at the tertiary level and adults who were not statistically literate.

Statistics at school level is taught within the mathematics curriculum as a topic on its own Burgess (2008). Furthermore Graham (2006, p.221) states that "the teaching of school statistics is located within the mathematics curriculum". Having similar concepts is one of the many reasons behind locating statistics within the mathematics curriculum. In the South African mathematics curriculum statistics is included as the fourth learning outcome in the FET phase. Statistical thinking is said to be a unique way of thinking compared to mathematics. Batanero, Burril and Reading (2011**)** explain the use of statistics for daily life and other disciplines which has led to the introduction of statistics at school level. In the view of Rumsey (2002) the introduction of statistics into the school mathematics curriculum is to raise awareness of the data in everyday life in aid of preparing learners for the current careers. According to Nickson (2000) statistics deals with everyday situations, such as an individual's favourite colour, the life span of a loaf of bread and the size of tomatoes in a particular area. Based on all these scenarios a collection of data is required in order to arrive at some outcomes and conclusions. These conclusions are communicated to individuals who are seeking information based on the scenarios on which the data is based.

Statistics also allows learners to engage with different questions which disclose different aspects of a situation in the media. Batanero, Burril and Reading (2011**)** emphasise that being statistically literate allows one to use statistics in the workplace, in one's personal life and as citizens. Teacher knowledge in mathematics is significant leading to the importance of statistical knowledge in order to teach statistics. Therefore a teacher's mathematical knowledge, according to Batanero, Burril and Reading (2011) has a significant role in the quality of teaching statistics. At the FET phase of Grade 10 -12 techniques and methods learnt in previous grades are used to investigate and solve the problems with which learners are engaged. North and Ottaviani (2002) believe that for statistical literacy to be achieved not

only statistics alone is needed, but appropriate mathematics skills are required. Graham (2006) is of the view that it is more possible that mathematics teachers have a better grounding of statistical ideas compared to teachers teaching other subjects making mathematics the grounding as an aid to the teaching of statistics. North and Ottaviani (2002) suggest that mathematics teachers need to be empowered on how to link statistics and mathematics in order for the teaching of statistics to be successful.

Mathematics teachers are considered more equipped to provide a solid and adequate foundation in the teaching of statistics. When teachers interact they learn from each other by engaging in activities and discussions and the ideas shared as a result of engagement allows for better teaching of statistics. Even though many mathematics teachers have a major in the subject mathematics, according to Batanero, Burril and Reading (2011) at present very few mathematics teachers have pedagogical training in statistics. Gattuso and Ottavani(2011) mention that teachers generally have no preparation for the teaching of statistics, limited knowledge about statistics and almost no training in statistics education. In the view of North, Scheiber and Ottaviani (2010), there is a generalisation that teachers make use of a traditional theoretical approach in the teaching of statistics focusing much emphasis on arriving at the correct formulae and performing calculations, as opposed to making use of real data to explain statistical principles, procedures and reasoning.

According to Garfield and Ben-Zvi (2008) it is expected that teachers develop an in- depth and meaningful understanding of statistics so that learners obtain the ability to think and reason statistically. Therefore more programmes like Math4stats need to be put in place to empower teachers in the content knowledge of statistics related to teaching statistics at school level. Batanero, Burril and Reading (2011) point out that empowering teachers to teach statistics in many countries is encouraged by many agencies in order to promote the introduction of statistical literacy in schools. According to Zewotir and North (2011) it is in the interest of all South African role players in education and society to work collaboratively to promote statistics education at school level. Irrespective of how big the challenges maybe in introducing statistics at school level in South Africa, the introductory of statistics has the potential to improve basic statistical literacy of school leavers. Statistics being in the mathematics curriculum creates the assumption that mathematics teachers are competent to teach the topic adequately. It is assumed that mathematics teachers are the appropriate

individuals to teach the topic fluently. Therefore, according to Bansilal (2014) the implementation of statistics is the responsibility of mathematics teachers.

Gal and Ginsburg (2002) suggest that teachers teaching statistics should be aware of their learners' ideas, reactions, and feelings towards statistics. Garfield and Ben-Zvi (2008) explain that many teachers focus on computation and formulae when teaching statistics because they relate the teaching of statistics to mathematics. Yet there is a slight difference in the conclusion and final answers bearing in mind that in statistics there is no precise and single answer. In statistics the answer is considered and valued correct if it is supported by a valid and reasonable explanation whereas, according to Chick and Pierce (2010), in mathematics there needs to be a precise and single answer. Learners are expected to engage with data in significant social, economic and environmental contexts exploring relevant issues such as HIV/ Aids, crime, abuse and environmental issues. Statistics, according to Goodall (2002), entails very practical issues with methods able to solve a variety of situations. The learning of statistics should not merely rely on formulae but should enable learners to engage with examples from real life. According to Batanero, Burril and Reading (2011) working with real data assists learners to understand and relate to issues that are not often included in textbook problems.

One of the goals for teaching statistics is to make the learning of statistics a positive experience for learners and teachers should bring interesting and engaging examples that will motivate them. The use of such examples learners are made aware, according to Goodall (2002), of the significance of statistics to everyday life. Ramirez and Bond (2012) emphasise that improving learners' attitudes towards statistics allows for better motivation and engagement in improving the cognitive learning outcomes. Garfield and Ben-Zvi (2008) claim the literature on the methods of teaching statistics is closely linked to the literature on the teaching of mathematics for the following reasons. Firstly, statistics is often taught as part of the mathematics curriculum, by teachers trained in mathematics and working in a mathematics department. Secondly, statistical theory has often been taught as a mathematical theory. Similarly, Moore and Cobb (2000) explain that statistics is taught as a unit of mathematics because it allows learners an opportunity to see positives in statistics in making sense of our world. Batanero, Burril and Reading (2011) claim that statistics is not an independent topic in the school curriculum but taught as a topic in the mathematics curriculum. By using examples that compare and organise information, demonstrate trends

and enable predictions can show learners how statistics benefits us in planning for the future. Goodall (2002) claims these examples motivate learners to be interested and simultaneously give them an idea of career paths that require statistical knowledge.

One of the difficulties that teachers encounter in the teaching of statistics, according to De Wet (1998), is language, especially learners who are historically disadvantaged According to Meletiou-Mavrotheris, Paparistodemou, Mavrotheris, Azcárate, Serradó and Cardeñoso, (2008) being statistically literate has become a significant skill for living in this information era. De Wet (1998) outlines other difficulties encountered with teaching previously disadvantaged learners: a poor mathematical background, language, socio economic background and computer literacy which are a few of the issues that contribute to negative attitudes and less effective teaching of statistics. This illuminates the fact that statistics is significant in our daily living. Without statistics we are unable to reach conclusions. According to Arnold (2008), as much as teachers emphasise that learners are to become lifelong learners, so too must teachers be lifelong learners in order to make learning more effective.

Using real world examples in the teaching of statistics enhances and motivates the learning process for the learners for which the teaching is targeted, incorporating examples to which learners are able to relate such as sport related examples, examples related to domestic data and examples that relate to the school context such as test results. It is important to use familiar data such as test results to determine the measures of central tendency, box and whisker plots, five number summary and the interquartile range. The use of real data allows for an increase of interest and participation in the learning process. Chick and Pierce (2010) further elaborate that one of the goals of statistics is being able to interpret and evaluate real world data which allows for the learners to be a part of and engage with the learning process. According to McCusker, Nicholson and Ridgway (2010) statistics is very much in line with solving interesting, relevant and realistic problems, therefore statistical reasoning is a powerful tool in making sense of real world problems and situations. Statistics teaching prepares learners for the world they are to face after school. Lee (2010) supports the idea of learners making sense of their own understanding. This enables learners to construct their own meaning after learning has taken place and presents opportunities for the learners to be critical thinkers when faced with data to be analysed and interpreted. Important decisions are

made based on the data available to statisticians. This demonstrates the relevance and significance of statistics in the data driven world in which we are presently living.

Teaching statistics especially within the South African context involves the teaching of graphs, data collection, and interpretation of information, measures of central tendencies, communication and discussion. The teaching of statistics has similarities to teaching mathematics; however statistics focuses more on communication as opposed to proof. Wessells (2008) views statistics education in South Africa as being still in its infancy due to many teachers being minimally empowered in the topic. Batanero, Burril and Reading (2011) further state there is a need for increased empowerment of primary and secondary school mathematics teachers, who are responsible for teaching mathematics at these levels. Much needs to be done to prepare mathematics teachers to teach the statistics topic in such a way that learners are statistically literate when they leave the school system. University courses will have to be aligned with the needs of the 21st century and will have to be based on the growing body of recent international research in statistics education. In order to be able to achieve the goal of increasing the level of statistical literacy in our citizens and country, support from the National Department of Education, mathematics education departments at universities and Statistics South Africa will be needed to ensure that we have a statistically literate nation as we are presently living in a data driven society and era.

2.7 Teaching methods used in statistics

According to Hellar and Mnyanyi (2008), the term method refers to the planning and directing of an activity to achieve something. If concepts are to be learned, certain necessary conditions must be present. Some of the factors that a teacher has to bear in mind when deciding on the choice of the teaching method are : the topic, nature of the objective to be met, teaching environment, the learners' background ,such as their age, prior knowledge and ability and the type of instructional material that can be used.

There are several methods available for teaching most mathematical topics such as statistics with reference to this study. These are some of the guidelines for selecting a method: the method should be mathematically correct, should have meaning for the class, should meet the demands for a proper teaching procedure and should motivate both the teacher and learners. According to McTighe and Seif (2003) teachers should create situations in which learners ask questions, develop strategies for solving problems and communicate with one another.

Learners are often expected to explain their answers and discuss how they arrived at their conclusions.

The following methods, brainstorming, discussion, demonstration, lecture or presentation and independent study are methods that can be used in the teaching of statistics since statistics is a component of the mathematics curriculum and is closely associated with mathematics. These methods have a link to the topic of statistics in the following manner: Brainstorming: is a way to generate multiple ideas in which the conclusion is suspended until a maximum number of ideas have been generated, the method of brainstorming relates to statistics in that each circumstance has unique data therefore the answers cannot be precise.

Discussion: Within this method the learners exchange points of view whilst working via a problem solving process, in relation to statistics the points of view are greatly presented by the data driven, however still using the same methods and concepts yet arriving at different conclusions.

Demonstration: It is performing an activity in order for learners to observe the manner in which it is done in order to help prepare learners to transfer theory to practical application. In any topic demonstration is vital in the introduction of the concepts and content that is required and necessary within the topic. Within the topic of statistics practical examples are used to demonstrate how the data can be used. The data is demonstrated by using various examples such as: weather reports, health reports, sports reports and educational reports. According to Hellar and Mnyanyi (2008) examples that learners encounter outside the classroom and on a daily basis are to develop an awareness of and capacity to judge statistical information.

Lecture or presentation: It is primarily a presentation of information, normally to a large group. Teaching in a school environment always pertains to a large group whereby information is being presented in various ways. The majority of lessons taught begin with a lecture or presentation method in order to disseminate, communicate and present information.

Independent study: is designed to enhance and support other instructional aids. Learning activities are typically done entirely by the individual learner using resource materials or using computer based technology. All this is applied once the learners have acquired the

appropriate content knowledge in order to use it when working on their own; therefore they apply what they have learnt within the context with which they are confronted.

The methods listed above, have been discussed in the teaching methods used in mathematics. Therefore the methods used to teach mathematics are closely associated and related to the methods that are employed in the teaching of statistics.

2.8 Conclusion

This chapter presented an extensive review of the literature regarding mathematics in general, teaching of mathematics, teaching methods used in mathematics, statistics in mathematics, the teaching of statistics and the teaching methods used in statistics. Mathematics becomes meaningful if the learners' experiences in the learning process are related to the real world. The relevance in the teaching of mathematics and specifically statistics is created when learners are able to associate the mathematical and statistical concepts with their own experiences and the real world.

CHAPTER 3
THEORETICAL FRAMEWORK

3.1 Introduction

The study explores the teaching of statistics at Grade 10 level. This study is framed within two theories, which are Social Constructionism and the theory of Teacher Knowledge, more specifically, pedagogical content knowledge (PCK). According to Lock and Strong (2010), social constructionism has a special focus on the meaning and understanding of human activities**.** The teaching that learners receive needs to be relevant and applicable to their daily experiences. This can be achieved by using examples that are applicable to the learners to support the content needed to be taught. Consequently, the teacher needs to be knowledgeable of the content as well as of the learners being taught. Verloop, Van Driel and Meijer (2001) propose that teacher knowledge needs to be linked to a teacher's experiences and situations within the classroom as well as outside the classroom environment. According to Hill, Rowan and Ball (2005) mathematical knowledge for teaching contributes to the learner's achievement in mathematics, being mindful that teacher knowledge with particular focus on PCK is the foundation of the teaching process. The current study seeks to explore the teaching of statistics in Grade 10 within the mathematics curriculum.

3.2 What is Social Constructionism?

According to Lock and Strong (2010) social constructionism has a relationship with human activities. The content taught to learners needs to be relevant and applicable for understanding to prevail. According to Young and Collin (2003) social information can be used as a source to deliver the content needed to be taught**.** Knowledge and skills taught should not be merely transmitted to the learner by the teacher; instead the learner should construct and reconstruct the knowledge and skills acquired. Touminen and Salvolainen (1997) mention that the use of information may be viewed as constructive and functional when it is put into action, therefore information is a guide to human activity and needs.

Social constructionism focuses on a social experience as opposed to individual encounters and abstract examples. Hoffman (1990) explains that social constructionism is a sociological theory of knowledge that examines how social action or objects of consciousness grow in social contexts. The learning and teaching of statistics in mathematics is considered an active

process where the data used is meaningfully, socially constructed. Andrews (2012) also mentions that social constructionism originated as an attempt to come to terms with the nature of reality and emerged almost thirty years ago, with its origins in sociology. It has been associated with the postmodern era in qualitative research. According to Hoffman (1990) social constructionists challenge the idea of one truth and question the validity of objective research. Andrews (2012) explains that the origins of social constructionists are traced to be an interpretivist's approach to thinking; interpretivists value human experience and seek to develop an objective to study and describe it.

The social constructionism theory allows for the interpretation of human activity in daily interaction which is utilised and seen as information. Therefore the social constructionist theory demonstrates the importance of society and social interaction amongst human beings and their daily activities. Moreover according to Schwand (2003) constructionists also view knowledge and truth as created and not discovered by the mind. The knowledge and truth is constructed socially since it is extracted from human activities and human beings themselves.

3.2.1 Social constructivism

I am fully aware that there are similarities between social constructivism and social constructionism, whereby social constructivism in mathematics is a theory which encourages learners to construct meaningful understanding of mathematical knowledge from what they know to what they do not know, thus allowing the learner to construct and reconstruct knowledge on their own. Powel and Kalina (2009) describe social constructivism as a highly effective method of teaching from which all learners are able benefit since collaboration and social interactions are integrated. Lev Vygotsky was the father of social constructivism believing in social interaction and that it is a crucial part of learning. Social constructivism is based on the social relations a learner experiences in the classroom along with a personal critical thinking process. Social constructivism engages learners in activities that create relationships that will directly relate to what they learn. It includes activities where learners experience their level of understanding and seek assistance to get to the next level, which provides a relationship between learner social experiences as being part of human development.

Nonetheless, the two theories have similarities: However, social constructionism has more relevance and is more suitable for this study as it leans more towards human activities and not

only the social aspects. Social constructionism also incorporates intellectual and abstract human activities in the learning process which are of future relevance and benefit to the learners.

3.3 Social constructionism theory and its relationship to the teaching of statistics

Statistics at school level is taught and categorised as a topic within the mathematics curriculum since it entails concepts that require mathematical calculations. According to Sremac (2010) social constructionism theory can be integrated with statistics to examine how teachers relate the statistics that is taught at school level to real world social contexts. Social constructionism and the teaching of statistics share common ideas about the nature of social reality used within the teaching of statistics.

Similarly, social constructionism is used to uncover the ways in which individuals and groups participate in the creation of their perceived social reality as statistics is based on information it receives from society. Statistics deals with data that is gathered from society which is then analysed and presented thereafter as information and findings. We experience everyday reality as something fixed that is taken for granted within society. Our knowledge of reality is actually constructed socially through human activities and most knowledge is developed, transmitted and maintained in social situations. The ways and means by which understanding is achieved of the world and ourselves are socially derived products of historically and culturally situated interchanges amongst people. The world in which people live and interact with presently is highly data driven, which gives rise to the need for statistics leading people to depend on statistics in their frequent decision making.

Living in a highly data driven society gives rise to an understanding of the importance of statistics, focusing on the mathematics curriculum within the context of South Africa. The teaching of statistics allows for learning in the classroom to be related to real world scenarios, whereby the teacher facilitates and guides the learners to understanding the importance of statistics in the world we live in and enabling learners to construct meaningful understanding of mathematical knowledge of statistics of what they know to what they did not know. The information that we receive from our statisticians and Census conducted every ten years provides us with understanding of our country, ourselves, as well as the changes in the country. Statistics enlightens us as citizens about the global changes and the changing society

around us, which brings us to the significance of the introduction of statistics to our mathematics curriculum in order to produce statistically literate school leavers.

Knowledge is then constructed through daily interactions. However, learners need to understand their daily interactions and simultaneously make sense of what they see around them. Teaching should not be situated around the teachers teaching alone but focus is also placed on the importance of learner knowledge, implying that learners learn more effectively when they make the concepts and skills they have learnt on their own and apply them in their daily experiences. Therefore learners need to explore their knowledge and experiences by being involved in their learning process. This allows teachers to facilitate the process of teaching and learning. In the social constructionism approach, reality, according to Sremac (2010) cannot be objectively known; all that can be done is to interpret experiences.

3.4 Social constructionist theory and the study

Social constructionist theory is of value to this study in that it enables me to gain the participants' views, experiences and understanding of the significance of statistics in our society. It is the theory that is most conducive to understanding statistics since statistics is based on information that is abstracted from human activities, which is consolidated and interpreted in order to provide constructive knowledge and information to human beings. This assists in the planning and constructive process in the engagement of the world in which we live. This theory sets the right foundation for my study and allows for the participants in this study to understand, view and construct the teaching of statistics in the mathematics curriculum. The relevance of statistics in the real world is to prepare learners for the workplace and to also make them aware of their real world activities. It allows the teacher to use information from the social context of the learner and integrate it into the statistics content prescribed within the Grade 10 mathematics curriculum.

3.5 Pedagogical content knowledge

According to Shulman (1986) teacher knowledge includes subject matter knowledge, curriculum knowledge and PCK with an interconnection with each other. However, this study is framed within the framework of Shulman's theory of teacher knowledge yet leans entirely on PCK. Grossman and Richert (1988) understand teacher knowledge to be a body of professional knowledge that accommodates both knowledge of general pedagogical principles and skills and the content to be taught. Therefore, teacher knowledge focuses on

enabling teachers to fulfill their primary role of teaching subject matter using appropriate pedagogical principles and skills. The study focuses on the process of teaching statistics at Grade 10 level within the Durban South Region.

Shulman's theory of teacher knowledge compromising PCK is compatible for the study because, Shulman (1986) states that a teacher's understanding of the subject's content knowledge and the delivery of the content have an interconnection in the instruction and teaching provided to learners. Gess-Newsome (1999) claims that subject knowledge, pedagogical knowledge and curricular knowledge all have an impact in the teaching practice of the classroom. According to Shulman (1986) the knowledge of teachers has become the focal point to policy makers and the education sector. The present matric results have been the cause of this attention making education a topical issue. According to Jansen (2015) the new CAPS curriculum aims to improve the quality of education. Furthermore the performance of learners in the Annual National Assessments (ANA) that are being conducted enforces understanding of what should be taught in order to ensure efficient distribution of resources where needed. The accountability in the assessment has a particular role to play in improving teaching and learning. Moreover, the quality of teaching has an effect on the performance of learners, requiring teacher development to build content knowledge.

3.6 What is pedagogical content knowledge?

According to Cochran, King and DeRuiter (1991) PCK is a type of knowledge that is different to teachers which is the reality and fact of teaching. Shulman (1986) suggests that a teacher's expertise should be measured and observed in their PCK which can be considered the foundation of the teaching process as without content knowledge teaching cannot occur. The importance of the teacher is vital as teaching is the transferring of knowledge from the teacher to the learners. The teacher may be a subject area expert; however, PCK is required for the learning process to take place.

PCK is different to every teacher, whereby the manner each teacher relates their teaching knowledge within the classroom situation has an effect on the teaching process. According to Shulman (1987) PCK is a specialised form of knowledge for teaching. It integrates all the different components of knowledge in order to adapt the teaching to the diverse environments with which teachers are presented. However to be a teacher requires extensive and proper organisation of knowledge. A teacher's knowledge has a huge impact on classroom practice.

The most important factor in a teacher's knowledge is to carry out the role of teaching. According to Gess-Newsome (1999) subject matter together with teaching is PCK which is used and has an important influence on the teaching process in the classroom.

Each teacher uses his or her pedagogic knowledge differently in order to get the content knowledge across to the learners. Therefore, pedagogic knowledge is a crucial component when delivering content knowledge within the classroom. PCK has an influence and effect in the manner in which the subject and topic is being taught. Integrated PCK and content knowledge enhance a positive learning environment within the classroom. This allows for the learners to gain better understanding towards the topic being taught. According to Shulman (1986) PCK compromises an understanding of the learning of specific concepts that are taught in order to make concepts much easier or more difficult.

However, this study focuses more towards PCK as it gives provision and means of representing and formulating information to make it easier to understand. According to Shulman (1987, p.8) "Pedagogical content knowledge illustrates a distinction between content specialists from that of pedagogue". This implies that PCK is a significant factor within the classroom more precisely to specific subjects and topics. Teachers need to have adequate pedagogical knowledge in order to deliver comprehensive teaching.

3.6.1 Components of pedagogical content knowledge

According to Shuhua, Kulm and Zhonghe (2004) PCK for effective teaching requires three components which are knowledge of the content, knowledge of the curriculum and knowledge of teaching. In these three components, each one has a significant contribution within the classroom. Firstly, knowledge of the content consists of the knowledge the teacher has for that specific subject and the level being taught. Knowledge of the curriculum consists of a proper selection and suitability of curriculum material to be used in the teaching process. Secondly, there must be an adequate understanding of the curriculum material to be used. According to Stipek, Givvin, Salmon and MacGyver (2001) a teacher's knowledge about mathematics filters through the teaching process. Thirdly the knowledge of teaching where the teacher has to possess knowledge about the learner's thinking, language to use when giving instructions and learner's prior knowledge of the topic being taught. According to Shuhua, Kulm and Zhonghe (2004) all three components are needed in the teaching process

as one is not sufficient for effective teaching. Therefore an effective teacher needs to possess all these components that make up PCK.

3.7 Pedagogical content knowledge and teaching statistics

Teaching requires the teacher to transform the subject matter in order for the learner to make meaning of the content. The purpose is to find and utilise multiple ways and examples to ensure understanding takes place in the teaching process. The examples that the teacher uses are to reinforce the subject matter being taught, enhancing the teaching process. A variety of examples need to be used to reiterate the content knowledge to eradicate misconceptions, as well as in the process and the content needs to be integrated within the examples used to teach the subject matter.

Cochran, King and De Ruiter (1991) elaborate by saying being able to identify specific concepts in a variety of levels and viewpoints depend on the needs and capabilities of the learners being taught. It is vital for teachers to also understand the learners they teach and engage with, especially in terms of learners' prior knowledge on the content the teacher is teaching. According to Cochran, King and De Ruiter (1991) describe PCK as a type of knowledge that is different to teachers which is the reality and fact of teaching. Therefore, Gess- Newsome (1999) claim that PCK is a fundamental part of teaching. It is concerned with the way in which teachers understand their pedagogical knowledge. They use what they know about teaching to integrate pedagogical knowledge and subject matter compromising PCK which is that type of knowledge that makes teachers, teachers as opposed to subject experts.

PCK is associated with experience because the more experience a teacher possesses the more value they have in the classroom. Pedagogical knowledge enables a teacher to transform content into ways which are conducive to the variations in the ability and backgrounds presented by learners. Therefore PCK is knowledge that is effective for teaching. Content knowledge alone cannot be sufficient for effective teaching to take place. An effective teacher needs to also possess a deep and vast knowledge of teaching and profound PCK. Ultimately these knowledge concepts simultaneously enhance the process of learning in order for the learners to benefit effectively, whereby effective teaching promotes thinking in a variety of ways. It is becoming very clear that both teachers' pedagogical knowledge and teachers' subject matter are vital to excellent teaching and learner understanding.

According to Cochran, King and De Ruiter (1991) another significant component in PCK is the teachers' reasoning based on the background, social, political and cultural environments in which the learners are compelled to learn. The learning environments are continuously changing with the educational changes. The teaching process is also simultaneously changing, thus learners and teachers are forced to adapt to the changes. PCK is said to be acquired with years of teaching experience.

PCK plays an important role in the concepts being taught which is more than just the subject matter, since it develops with time as a result of experience in many classroom environments. Cochran, King and De Ruiter (1991) claim inexperienced teachers display incomplete levels of PCK. These teachers rely on subject matter that is provided in the curriculum materials and find difficulty in relaying the content to the learners because prior knowledge and ability levels are not assessed. According to Croninger, Rice, Rathbun and Nishio (2007) the teacher has an influence in the teaching process. The use of routine questions in the teaching process has been associated with low levels of PCK. These teachers tend to disregard learners' prior knowledge before teaching the lesson and subject content. A professionally prepared teacher should have measures and procedures in place to deal with the diverse needs of learners in their classrooms.

The construction of PCK results from many opportunities to teach, observe and through introspection of one's own teaching together with content knowledge. In order to be able to develop PCK it requires early and continued interaction with opportunities to teach, with follow up reflections and feedback. This provides a platform for teachers to develop and become able to apply their PCK positively within the classroom. A suggestion to achieve this is the involvement of experienced teachers in mentoring newly graduated teachers by allowing them to observe and take valuable ideas from the experienced teachers**.** Gess-Newsome (1999) points out that a very significant aspect of PCK is teaching experience, where it is applied effectively in the diverse classroom situations. This allows for learners to excel because of the influences teachers possess and bring into the classroom.

Croninger, Rice, Rathbun and Nishio (2007) argue that the single most significant factor affecting the learner is the teacher; therefore influences of teachers on learner achievement are both valuable and beneficial. This serves as a major help for teachers' classroom settings and situations in creating a conducive learning environment. In the view of Berry, Loughran

and Van Driel (2008), currently there is a demand of time and curriculum expectations to follow with the monitoring of learners' achievements which tend to be the central focus within the teaching process. Hill, Rowan and Ball (2005) view poor performance of learners largely as influenced by teachers' lack of essential knowledge for teaching mathematics. Significantly, teaching should be better understood and valued as it is an expectation within teaching.

Berry, Loughran and Van Driel (2008) assert that one of the ways of accomplishing this expectation is through the construction of PCK. Furthermore Bill, Hill and Bass (2005) are of the belief that a teacher's mathematical knowledge enhances learners' understanding and hence their achievement. Therefore the focus is not only what happens in the classroom but rather offering insights on how to improve the teaching and linking the significance of PCK. Krauss, Baumert and Blum (2008) are of the opinion that PCK is expected in the lesson quality and learners' learning. Shulman (1986) further characterises PCK as the knowledge required to make the content more understandable to the learners. As learners are the recipients of the content and teachers carry out the task of implementation, teachers need to comprehend the content they deliver in the classroom. Furthermore the role of a teacher within the classroom situation is to be well equipped with PCK. This includes the knowledge of learners and their characteristics relating to their educational situations, implying that the teacher needs to possess the ability to transform the content into ways that can conform to the learners and learning environment presented. The key component of PCK is having the content knowledge as well as the capability to teach this content.

3.8 Pedagogical content knowledge and its relationship to mathematics

According to Shulman (1987) a teacher who presumes to teach content must demonstrate knowledge of that content as a prerequisite to teaching with understanding. PCK has a strong relation to the subject of mathematics. However, Stipek, Givvin, Salmon and MacGyver (2001) suggest that a teacher's beliefs and values have an effect on the teaching and learning. The objective is to understand the manner in which the teacher understands and views mathematics teaching. Ball, Thames and Phelps (2008) state that teachers need to understand the subjects they teach and utilise classroom practices that actively engage learners to construct mathematical concepts. Consequently, according to Stipek, Givvin, Salmon and MacGyver (2001), the role of the teacher is to provide support and guidance in this process of constructing mathematical concepts rather than transmitting discrete knowledge.

Krauss, Baumert and Blum (2008) maintain that practice; theory and expertise do not increase by simply doing a job but rather through motivation and concerted practice as a requirement to overcome one's weaknesses, preferably with the support of continuous experienced feedback. According to Ball, Lubienski and Mewborn (2001) teachers play a significant role in the teaching of mathematics to their learners. Krauss, Baumert and Blum (2008) believe teachers with high PCK tend to see mathematics as a process which leads to new discoveries. Also mathematics can be best learnt through careful listening. Furthermore, mathematics should be learnt by self-discovery and independent activities that incorporate real insights. Ball, Lubienski and Mewborn (2001) are of the view that mathematics in classrooms is at the heart of mathematics. Krauss, Baumert and Blum (2008) add that PCK is a necessary requirement for teachers to create a powerful learning environment that supports the learners' learning situation. This results from the understanding that learning is the ultimate aim of teaching. It is said that mathematics teachers are professionals on two aspects; they are professional mathematicians and professional teachers. PCK is the crucial aspect of teaching with a particular focus on mathematics. This asserts that teachers' own knowledge of mathematics is an important resource for teaching.

An important aspect is that PCK is a distinct type of knowledge that integrates content with aspects of teaching. Ball, Lubienski and Mewborn (2001) claim even expert personal knowledge of mathematics can be insufficient for teaching. It requires a unique understanding that intertwines the aspect of teaching which creates challenges in making use of mathematical knowledge in practice. Teaching is a demanding process in that teachers need to deal with numerous issues and the application of PCK is required to ensure all situations within the classroom are catered for. However, to teach one firstly needs to have an understanding. Shulman (1987) notes that an expectation is that teachers understand what they teach and, moreover are encouraged to understand the content in several ways, allowing the leaners to understand how a certain idea relates to other ideas within the same subject area.

According to Ball, Thames and Phelps (2008) the knowledge of content and teaching is a combination of knowledge that includes knowing about teaching and mathematics. Shulman (1987) further views the knowledge base of teaching is connecting content and pedagogy, whereby the role of teachers is to transform the content knowledge they possess into ways

that are pedagogically beneficial to the learners they teach. The majority of mathematical tasks of teaching require mathematical knowledge that includes the design of instruction. Mathematics teachers need to be able to sequence particular content for instruction and also need to decide which examples to utilise in taking learners deeper into the content.

Another aspect teachers need to evaluate is the instructional advantages and disadvantages used in representing specific ideas. Ball, Thames and Phelps (2008) present numerous mathematical tasks such as responding to leaners 'why' questions, identifying an example to make specific mathematical points, the connection of a topic being taught to topics from prior or future years, modifying tasks to be either easier or harder and asking productive mathematical questions. This is an implication that teachers need to know a body of mathematics not only typically taught to learners, therefore teachers need to have more content knowledge than the learners. Krauss, Baumert and Blum (2008) are of the belief that PCK is an important component in the teaching process in aid of creating a powerful learning environment that supports the learners' learning situation. Ball, Thames and Phelps (2008) concur that mathematical demands of teaching require specialised mathematical knowledge.

According to Nies (2005) how teachers learnt their subject matter, is not necessarily the way their learners will need to be taught. Teachers need to use their PCK in order to make concepts easier for the learners to understand. Abell (2008) describes the learning of mathematics as not being a set of tricks based on general teaching strategies but is rather having to do with developing complex and contextualised knowledge to specific problems. PCK helps to recognise the knowledge needed for teaching mathematics is different from the knowledge required to teach literature. According to Nies (2005) further emphasis is placed on problem solving in mathematics using real world situations as the real world is rich in technology. When teaching mathematics, it is essential to integrate technology and real world situations.

Loughran, Mulhall and Berry (2004) explain how a teacher may not be fully aware of a particular topic. According to Nies (2005) the integration of technology in the curriculum has seen a recent shift in the past decade. This requires communication and technology to eradicate such hindrances within the pedagogical process. According to Loughran, Mulhall and Berry (2004), a teacher's PCK may not be ascertained in the observation of a single lesson but rather in a series of observations. It has been found that particular types of content

knowledge and pedagogical strategies are needed in the interactions of the teachers' minds in the teaching of mathematics. In the view of Shulman (1987) the learners who are being taught need to be well trained in mathematics because they become the future adults with others becoming teachers. The quality of mathematics teaching, according to Ball, Hill and Bass (2005) depends on the content knowledge of the teacher.

Teachers are more confident and prepared when they are well affirmed and experienced with the content which has an impact on the mathematical knowledge of the learners as they enter the adult working world, especially when learners enter tertiary level with their uneven and inadequate knowledge of mathematics. Therefore, a teacher's content knowledge within a subject is vitally important as it has an impact on the learners' future knowledge and success. It is clear to Ball, Hill and Bass (2005) that it is a problem and challenge which is encountered requiring improvement. Nies (2005) adds that a shortage of mathematics teachers is another major concern within the teaching of mathematics including the retirement of well trained teachers. Their pedagogical content knowledge is lost as the new teachers entering the profession have a limited amount of mentorship from experienced teachers within the profession already; however subject matter knowledge is obtained through many years focusing on personal learning and construction of how the subject is known. Stipek, Givvin, Salmon and MacGyver (2001) recommend that teachers create classroom practices that engage learners in activities that assist them to construct mathematical concepts. Teachers should provide activities that require reasoning and creativity in gathering and applying information and be able to self-discover and communicate ideas effectively.

According to Van Driel, Verloop and De Vos (1998) when experienced teachers apply a coherent and integrated set of knowledge and beliefs this contributes positively and plays an important role in the teaching of mathematics. Shulman (1986) is of the belief that teachers should have a thorough understanding of the mathematics content needed to be learnt in order to appropriately teach; implying that if a teacher is knowledgeable regarding the content the teaching will be of great benefit to the learner as well as the responsibility of learning remaining within the learners themselves. Furthermore, the PCK has an influence within the pedagogical process. According to Shulman (1986), PCK is a combination of content and the pedagogy into an understanding of how particular topics are presented and adapted to the diverse instructions. Teachers must be able to achieve the standards of mathematics through their PCK without any standardisation.

Ball, Hill and Bass (2005) add that teachers' mathematical knowledge provides an increase in the learners' achievements. This leads to an increase in the standard of mathematics and PCK of the teacher. An increased understanding of the content knowledge of the teachers results in an increased benefit in the learners which is visible through their achievements. Nies (2005) claims a mathematics teacher preparation programme is expected to develop two aspects that are depth and breadth in the content knowledge. Ball, Hill and Bass (2005) further state that teachers need to be thoroughly knowledgeable to be successful in teaching the learners in the classrooms, which allows for the objectives and goals to be achieved with the guidance of PCK. PCK has an immense amount of influence in the teaching of mathematics as it is an integration of teacher knowledge and content knowledge. The two aspects of knowledge in conjunction allow for pedagogical knowledge to be complete. PCK is applicable in the teaching of mathematics and has a special relevance to the subject.

3.9 Pedagogical content knowledge and mathematics teaching

The teaching of statistics lies within the subject of mathematics at school level. According to Ball, Thames and Phelps (2008), in the success of teaching, understanding the content is significant. Teacher knowledge is vital which is also referred to as PCK within the teaching of any subject; however, within this study the focus is on the teaching of statistics more precisely at Grade 10 level. PCK frames the study by conceptualisation of the mathematical knowledge and skill required by teachers, in teaching statistics as a sub topic within the secondary school mathematics curriculum. Ball, Lubienski and Mewborn (2001) emphasise that a teacher's own knowledge is an important resource for teaching statistics.

Furthermore, Shulman (1987) raises the concern of teacher competency, implying that empowerment of teachers to have the required pedagogical knowledge is significant ensuring they are adequately competent when teaching. Ball, Lubienski and Mewborn (2001) claim teachers need to be knowledgeable with the mathematical content to be capable and adequately competent to teach statistics. A simple explanation would be being prepared to teach a specific curriculum as a first step in the right direction and secondly, having mathematical knowledge in aid of doing the mathematical requirements within the teaching of statistics. It is important that teachers know the content of what they teach, which is defined by a curriculum that needs to be followed.

According to Ball, Lubienski and Mewborn (2001) curricular knowledge is represented by the documents designed to teach particular subjects and topics at a given level. Ball, Thames and Phelps (2008) emphasise that teachers need to be knowledgeable in the curriculum requirements that are required to teach the learners at that particular level. A curriculum is used as a guide and directive to the teacher on what content to teach at a particular grade level. According to Jones, Mooney and Harries (2002) in order to teach a topic like statistics in the mathematics curriculum effectively and confidently the teacher needs to be adequately equipped and trained. Ball, Lubienski and Mewborn (2001) suggest providing more courses in mathematics being accompanied by approaches to teaching mathematics.

This is congruent with the current workshops run by Statistics South Africa in conjunction with the University of KwaZulu-Natal in collaboration with the Department of Education in training mathematics teachers in the topic of statistics within the mathematics curriculum. These workshops and courses provide guidance to teachers on the required content knowledge to deliver in the classroom. They are conducted on Saturdays in order to ensure minimum disruptions in the teaching process, providing support to teachers in PCK in relation to the teaching of statistics.

Jones, Mooney and Harries (2002) describe PCK as an understanding of how to present topics such as statistics in ways that are appropriate to the learners for whom the content is aimed. This means being able to deliver the content at the level of the learners being taught, providing an allowance for the teaching of mathematical concepts and procedures from simple to complex to be accomplished, ensuring the teaching is successfully understood. Ball, Thames and Phelps (2008) reiterate that teachers need to know the topics that they are required to teach and the required procedures in the teaching of statistics. The focus needs to lean on how teachers need to know the content of teaching statistics. Furthermore teachers ought to find ways in which mathematics and the topic statistics are integrated so that they are relevant to the day to day demands of teaching. Stipek, Givvin, Salmon and MacGyver (2001) suggest that teachers create classroom practices that engage learners in activities that are familiar and assist them to construct mathematical concepts. Ball, Thames and Phelps (2008) are of the view that teachers need to incorporate everyday life examples in the teaching of statistics. The inclusion of everyday life examples is to achieve understanding of the content required to be taught so that it becomes valuable and meaningful to the learners. Jones, Mooney and Harries (2002) continue to emphasise that continuation of empowering

and educating mathematics teachers in terms of their content knowledge leads to successful teaching of mathematics focusing particularly on statistics. Success in the teaching of statistics depends on the amount of knowledge the teacher has acquired in statistics and how to teach it effectively.

According to Abell (2008) teachers do not only possess PCK they employ the components of PCK in an integrated manner as they plan and deliver their lessons. PCK allows for teachers to incorporate individual components to address their lesson in a way to ensure valued teaching takes place and eradicates problems on hand. It is important to allow the learners to apply what they learn within the curriculum to everyday practice. Ball, Thames and Phelps (2008) claim that many of the tasks teachers do with the learners require mathematical knowledge independent of the knowledge of learners. Abell (2008) states that teachers develop and use knowledge for teaching specific topics like statistics in mathematics with an understanding that PCK is developed over time. According to Jones, Mooney and Harries (2002) it is clear that a number of areas of mathematics such as statistics remain crucial and significant in mathematics education. It pertains to the quality of knowledge and how it is put into action.

As much as the study is framed within the theory of PCK as a component of teacher knowledge, I wish to point out that I am aware of Ball's theory of Mathematical Knowledge for Teaching, since my study is on mathematics teaching focusing on statistics at Grade 10 level. Nevertheless, PCK deals mainly with understanding what a teacher needs to teach together with the knowledge a teacher requires in order to deliver content in the classroom. Therefore the study focuses specifically on the teaching of statistics at Grade 10 level. Ball's framework for mathematical knowledge for teaching (MKFT) also has an important role to play within the teaching of mathematics. According to McAuliffe and Lubben (2013) MKFT identifies situations and tasks where content knowledge and teaching are integrated in the teaching process. It has a close relation to Shulman's theory of PCK whereas MKFT focuses specifically on mathematics teaching. Hill, Rowan and Ball (2005) claim teachers' mathematical knowledge is significantly related to learners' achievements. According to McAuliffe and Lubben (2013) a great deal of emphasis on learner achievements is related to the teaching by those who know about the subject. A teacher's content knowledge is a significant factor in the learner achievement as does a teacher's knowledge and experience have a significant impact on the learners' performance.

Moreover, mathematics teachers need to be prepared effectively in order to have extensive and vast subject matter knowledge together with PCK. The importance of mathematics teaching has led to the government, universities and non-governmental organisations initiating programmes and courses that can assist teachers. The programmes and courses provided focus on specific topics in the mathematics curriculum such as statistics. These stakeholders provide assistance in ensuring and improving teachers' mathematical knowledge in order to ensure better teaching is provided to the learners in the mathematics classroom. One of the many programmes and courses is provided by universities and Statistics South Africa in conjunction with the department of Basic education to empower and improve teacher knowledge. According to North and Zewotir (2006), in service workshops in statistics give teachers the opportunity to upgrade their knowledge so that they can teach the learners to be statistically literate when they leave school and for others who may be venturing to become statisticians.

However, if teachers are knowledgeable on the content and are well empowered their knowledge filters into the classroom where teaching takes place. According to Hill, Rowan and Ball (2005), poor performance of learners is largely influenced by teachers' lack of essential knowledge for teaching mathematics. In many instances, an influence on learners' achievements is congruent with a teacher's ability to understand and use of the content knowledge in the teaching process. In terms of being knowledgeable on the content does not imply only being able to arrive at the correct calculation, but being able to use other forms of demonstrations such as diagrams, pictures, videos and advertisements to represent the mathematical concepts being taught.

Having the required understanding of the subject matter allows the teacher to eradicate misconceptions from the learners they teach. Shulman (1987) suggests that all teachers are required to have an understanding of the content knowledge in order to link the relationship between the content and real life experiences. This form of understanding enables a solid foundation for PCK that allows teachers to build on which applies more specifically to statistics as it entails day to day related concepts.

Hill, Rowan and Ball (2005) continue to say the work taught in the classroom has an effect on the learner's achievement which directly pertains to teacher preparation and teaching experience. The main aim of ensuring mathematics teachers are well equipped and

empowered with mathematical knowledge is to ensure that learners gain greater achievement in mathematics. Hence, Shulman (1986) reiterates that PCK is ideal to understand teaching. This is to assist teachers acquire new understandings of their content which can be applied to strengthen their knowledge in the teaching of statistics. Therefore, according to Hill, Rowan and Ball (2005) being an effective teacher and being knowledgeable on the content lies in how this knowledge is applied in the classroom. Consequently, a teacher's knowledge, together with the time provided for the lesson, leads to quality teaching within the teaching process. Furthermore, teacher knowledge should be content specific in relation to the knowledge used in teaching learners.

Ball, Thames and Phelps (2008) describe the framework for MKFT as a product of the work of Shulman (1986) who identified content specific knowledge as subject matter knowledge, PCK and curriculum knowledge. The framework for MKFT, according to McAuliffe and Lubben (2013) makes use of Shulman's (1986) PCK, subject matter knowledge and curriculum knowledge categories, yet organises and defines them in a unique way. MKFT uses these three components differently by focusing on mathematics firstly thereafter common content knowledge, specialised content knowledge and horizon content knowledge in terms of subject matter knowledge. Subsequently, PCK is associated with the knowledge of content and teaching.

Lastly, curricular knowledge is knowledge of content and learners as well as knowledge of content and curriculum. However, MKFT requires a unique mathematical understanding and reasoning which entails knowledge beyond that which is taught to learners. McAuliffe and Lubben (2013) advise continuous empowerment of mathematics teachers in terms of their mathematical content knowledge. This deals with day to day mathematical encounters of teaching such as being able to explicitly explain, identify examples and representations, dealing with learners' queries and responses, selecting and modification of tasks and posing questions to learners. According to Hill, Rowan and Ball (2005) the performance of learners is largely influenced by the teachers' knowledge for teaching mathematics.

Therefore, according to McAuliffe and Lubben (2013), historically, school mathematics has been seen as a developing and changing process which followed an introduction of new components such as statistics. A large proportion of statistics in the mathematics curriculum requires mathematics procedures and knowledge. Therefore statistics allows the learners to

think and reason mathematically**.** According to Hill, Rowan and Ball (2005) the knowledge a teacher possesses lies in how it is utilised in the classroom environment. McAuliffe and Lubben (2013) suggest an early start to statistics education in the earlier grades to help cultivate habits of their minds to understand the mathematics required for their higher grades and other areas of mathematics, but more precisely statistics. The main purpose for early learning of statistics is to provide learners with a set of experiences that allows them to see mathematics and statistics as being useful in their future encounters.

However, Rowan and Ball (2005) view teachers' mathematical knowledge as being related to the learners' performance. Yet, MKFT does not, according to McAuliffe and Lubben (2013), focus on what the teacher accomplishes, but rather on the specialised knowledge needed for teaching through an analysis of the teaching tasks featured in the lesson. MKFT differentiates between the different kinds of knowledge needed in the work of teaching applied to analyse the PCK needed by the teacher in the teaching process. MKFT helps to elaborate a description of the knowledge needed for teaching mathematics. This framework of MKFT also demonstrates that with the correct kind of tasks and instruction learners can learn to think in ways to show how certain variables or quantities relate to one another. Nonetheless, PCK is still the appropriate and suitable theoretical framework for the study as it deals with exploring the teaching of statistics at Grade 10 level. PCK focuses on the accomplishment of the teacher within the classroom not only on the specialised knowledge needed to teach mathematics.

3.10 Pedagogical content knowledge and the study

PCK is an applicable theory to frame this study as it allows for a better understanding of the kinds of knowledge that practicing teachers use when they plan and carry out their lessons. In this study PCK contributes and adds value to the teaching of statistics. A thoroughly knowledgeable teacher contributes positively in the teaching process since pedagogical content knowledge in teacher knowledge is a combination of both pedagogical and content knowledge. PCK encourages the teacher to be knowledgeable on the content as well as possess appropriate, suitable and valuable methods in the teaching process. PCK in the study is closely related to the methods the teachers use in their lessons to deliver the content. The methods used by teachers to deliver the content, has a link to the PCK a teacher possesses. Since each teacher uses their preferred method in order to ensure quality and valuable teaching takes place. PCK promotes creative teaching to take place by integrating

pedagogical knowledge and content knowledge in achieving a single goal of successful teaching to prevail. Even inexperienced teachers apply the same principles as PCK guides them in their lesson preparation which in turn provides the necessary goals in collecting the data from practicing teachers. Teacher quality cannot be measured only by years of experience and knowledge of basic skills and subject matter. Deep knowledge of subject matter can also translate into quality teaching. Although in the view of Peske and Haycock (2006) experience makes teachers more effective. Therefore, teachers are considerably more effective after completing two years on the job.

3.11 Social constructionism and pedagogical content knowledge in the study

Social Constructionism and PCK integrated in the study play a significant role. It is very important for any teacher to be well prepared before teaching any class, subject and topic. According to Ball, Hill and Bass (2005) teachers need to be thoroughly knowledgeable to teach successfully in the classroom. To teach a topic like statistics within the mathematics curriculum a teacher requires pedagogic and content knowledge before they begin to teach. Social constructionism is an appropriate theory to understanding statistics since statistics is based on information related to human activities. Collectively these two theories have a significant role to play, PCK relates to the teaching and content knowledge required within the study and social constructionism pertains to the content and its relevance to the topic and content needed to teach. Social constructionism enhances the understanding required in the content imparted to the learner through the pedagogic process. Therefore together these two integrated theories are appropriate in framing the study. These two theories assist in analysing the data in that they are both relevant to the critical research questions in the study. Social constructionism is important in analysing how statistics is taught. According to Sremac (2010) social constructionist theory can be integrated with statistics to identify how teachers relate the statistics content that is taught at school level to the real world. Hill, Rowan and Ball (2005) claim the poor performance of learners is greatly influenced by teachers' lack of essential knowledge for teaching mathematics. According to Croninger, Rice, Rathbun and Nishio (2007) one of the factors affecting the learner is the teacher therefore PCK is vital in the teaching process and relevant in analysing the methods used to teach the topic.

3.12 Conclusion

This chapter explores two theoretical frameworks within which the research is framed. The chapter leads to an intense discussion of Social constructionism and the theory of Teacher Knowledge with specific reference to PCK. Social constructionism is a theory that encourages learners to construct their own knowledge from their everyday experiences, whereas PCK is the ability of a teacher to transform content into ways that learners are able to understand and to which they can relate. PCK is knowledge that is effective for teaching. The teacher needs to possess the ability to transform the content into ways that can conform to the learners and the learning environment presented.

CHAPTER 4
METHODOLOGY

4.1 Introduction

This study was conducted in the Durban South Region of KwaZulu-Natal and different schools in this region were purposefully chosen to participate. Before 1994 education in South Africa was segregated according to the different races, therefore there was an unequal distribution of funding, resources and access to education. The location chosen to conduct the study had easy accessibility to the diverse schools that were previously labelled according to different race groups, gender, and economic class. These schools provided diversity of data and the targeted participants for the study. This chapter presents the research methodology for the study, the process of data collection and the validity, reliability and ethical consideration are discussed.

The research questions

This study focused on exploring the teaching of statistics at Grade 10 level placing special focus on identifying the different teaching methods used by teachers to teach statistics. In addition this study explores how and why these methods are used by teachers teaching statistics at Grade 10 level.

The critical questions that this study aimed to explore were as follows:

1. What methods do teachers use when teaching statistics in Grade 10?
2. How is statistics taught in Grade 10?
3. Why are these methods being used by teachers when teaching statistics in Grade 10?

4.2 Research Approach

The study focused on exploring the teaching of statistics at Grade 10 level, where teachers' views, actions and opinions were explored. It is significant to note that the topic of statistics in the mathematics curriculum is new and unfamiliar to many teachers. Statistics (Data handling) is in the curriculum to reinforce the changing world we live in and changes in education and to create statistically literate individuals for the future. A qualitative method allowed for more understanding of the aims of the research. Flick (2009, p.12) claims "qualitative research is of specific relevance to the study of social relations". According to Cresswell (2012), when dealing with the day to day experiences, qualitative researchers

usually identify cases that are part of everyday life and usually focus on human factors**.** Likewise, Duemer and Sanderson (2008) are of the view that qualitative research is an activity that situates the researcher in the context which is being studied, using a school environment as a central point and field for the study providing value towards the study.

A qualitative method provided the study with credibility whereby the researcher observed and used field notes during each observation. According to Bogdan and Bilken (1997) a qualitative method allows for change and empowerment to take place. Kuper, Reeves and Levinson (2008) also describe qualitative research as a research methodology that enables valuable data and the exploration of real world behaviour which allows the participants to express themselves verbally and with their actions. Oliver-Hoyo and Alleen (2006) describe the importance of qualitative research as the process of investigation leading to certain results that the researcher wished to achieve. According to Cohen, Manion and Morrison (2011), the qualitative research method allows for data to be descriptive which is collecting verbal or textual data as well as the observation of behaviour. In this study the researcher explored the teaching of statistics at secondary school level, focusing specifically on Grade 10 level.

Similarly, Oliver- Hoyo and Alleen (2006) further claim that qualitative research is work done in order to understand what is socially constructed by individuals by engaging with the context in which they interact. In this study the researcher interacted with mathematics teachers who facilitated the teaching of statistics within the Grade 10 mathematics classrooms. These mathematics teachers deliver and implement the curriculum to the learners. These teachers were knowledgeable with the expectations of the curriculum as they delivered the content prescribed by the curriculum to the learners. Bashir, Afzal and Azeem (2008) are of the same view that it is common that a qualitative researcher is physically present at the research site to engage more closely with the participants. The physical presence of the researcher at the research site was done with the aim of gathering and receiving full value towards the critical research questions of the study. In a qualitative research method, according to De Vos (2002), the researcher is directly involved in the study. Furthermore, the use of the qualitative approach for this study allowed for flexibility due to the uniqueness of the research design. De Wet (1998) further describes qualitative research as a method used to gather significant information with the objective of developing an understanding on what the study is focused. The teaching of statistics within the Grade 10

mathematics classes is where focus was placed and observed. It was chosen to explore meaning and provide in-depth understanding of the research.

A qualitative research method allowed the researcher to gain information of the study through the participants' actions and verbal expressions. Kuper, Reeves and Levinson (2008) describe qualitative research as the generation of significant information, exploring realistic behaviour by allowing the participants to express themselves verbally through their actions and their teaching of statistics within Grade 10 mathematics classroom environments. The response of participants was achieved by conducting interviews (semi structured and unstructured), observations and by completing questionnaires. Qualitative research methods were created to assist the researcher to understand the participants and the social context within which they live and conduct their work. In this study, the focus was placed on a Grade 10 mathematics classroom, exploring the teaching of statistics at Grade 10 level. Researchers Bogdan and Bilken (1997) feel an action is better understood when it is observed in a setting where it takes place. Real and precise data was collected when the researcher was physically present in the setting where the data was collected. Duemer and Sanderson (2008), therefore conclude that qualitative research compromises an interpretive approach to the world.

According to Creswell (2003), in quantitative research, the researcher would have started with a test of theory and gathered the information based on what the participants had provided from the instruments. Also according to Struwig and Stead (2007) quantitative research is a form of research that can involve numerous different samples having well-planned methods of data collection. Within this study the participants' responses were of more value to the study. Creswell (2003) claims a researcher tests a theory by a particular hypothesis and then uses the information collected to support the hypothesis.

More often in quantitative research methods the researcher adopts strategies of enquiry such as experiments and surveys, using predetermined approaches and numerical data as well as measures information in a more numerical manner. Therefore Struwig and Stead (2007) emphasise that in quantitative research the data collected is to be reported in the form of numbers.

When comparing quantitative and qualitative research methods there are differences in the two methods. According to Denzin and Lincoln (2000) qualitative and quantitative methods

differ in their ideology of reality. Where quantitative research focuses on a particular hypothesis to follow, qualitative research follows an interpretivist approach where the researcher is then guided by data that is collected. The data collected steers the direction of the study. The topic of investigation is viewed separately from the researcher and is therefore independent in quantitative research where as in qualitative research the researcher is considered as part of the investigation.

According to Creswell (2003), in qualitative research the participant is able to express his/her view with the researcher having very little control of his/her responses as opposed to quantitative research that makes an attempt to control and predict the participants' responses. Struwig and Stead (2007) state that the relationship between the researcher and participant is very brief in the quantitative research approach. However with the qualitative approach there is a relationship that is developed between the researcher and participant, whereby the researcher attempts to understand and interpret the participants' point of view. In the quantitative approach there exists a more precise structure within the research process compared to the qualitative research approach.

Nevertheless there are short falls within the qualitative approach like having more flexibility being granted in the qualitative research with methods being planned as the research progresses. Therefore much data may be lost in the process according to Struwig and Stead (2007). The researcher has little control of the participants' responses which leads to the research having minimal structure as compared to a quantitative approach.

Having compared the two research methodologies I have found that a qualitative method has more merit and is more suitable for this research study, since it allows the researcher to be involved in the research study. According to Struwig and Stead (2007) when the researcher interacts more closely with the participants, it allows participants to be part of the interpretation of the research findings and have inputs on the researchers' interpretation of the data collected. Therefore the primary role of qualitative research is ascertaining an understanding of something. Within this study the researcher is able to understand how statistics is taught, the methods used in the teaching of statistics and why these methods are being used to teach statistics at Grade 10 level. The qualitative research method enables the researcher to be physically part of the data collection and engage with the participants. Thereby allowing each critical research question to be answered via the participants'

responses to the research instruments used. Each instrument was designed to answer a particular research question. The instruments used to obtain data in answering the research question of what methods are used to teach statistics is the observation and questionnaire; how statistics is taught and the instrument used was the observation. Lastly the semi-structured interview was used to answer why these particular methods were used.

4.3 Paradigm

According to Cresswell (2012**)** a paradigm is a worldview, where values, methods and beliefs occur in research. Qualitative research, according to Duemer and Sanderson (2008), involves an interpretivist approach to the world. This study used the interpretivist approach, which allowed the researcher to understand and describe the data meaningfully using human interaction. Voce (2004) claims that the interpretivist paradigm views knowledge as being constructed and knowledge being the way in which people make meaning in their lives. According to Cohen, Manion and Morrison (2011, p.17) "the interpretive paradigm is to understand the subjective world of human experience" by allowing the researcher to be physically present and involved at the research site and engage more closely with the participants.

Myers (1997) describes interpretive studies as attempting to meaningfully understand the data obtained from the participants. McCotter (2001) claims that interpretive researchers begin with understanding the participants first and thereafter aim to understand the participants' interpretations of the environment in which they work and teach in the context of this study.
Voce (2004) describes the interpretivist paradigm as a process where knowledge is being constructed. The researcher then constructs meaningful knowledge from their interpretation. Cohen, Manion and Morrison (2011) further claim that an interpretivist view concentrates on human action, behaviours and assumptions. Therefore the purpose of the research was to develop greater understanding of how teachers teach the topic of statistics within the mathematics curriculum at Grade 10 level.

Taylor (2008) states that the interpretivist paradigm allowed the researcher to understand and make sense of others' socially constructed ideas. The interpretivist paradigm was suitable for this study as the data collected was based on the ideas and actions of the participants. It enabled the researcher to interpret the data collected on how statistics is taught, the methods used to teach statistics and why these methods were used to teach statistics at grade 10 level.

The data was interpreted based on the responses from instruments used within the study. According to Bryman (2008) it allows learners to apply what is taught at school in their day to day experiences as well as to become statistically literate will enable them to become responsible citizens in the future. In the view of Guba and Lincoln (1994) results are usually created from results that are in existence already, therefore researchers use these results to create new findings by interpreting the data which is available to them. A true meaning of the results was understood when the researcher and participant interacted. Therefore Myers (1997) claims the choice in the research method and paradigm has great influence in the way in which the researcher collects his or her data. This research study was guided by the use of an interpretivist paradigm.

4.4 Data collection

The data collection process began with inviting twenty teachers in ten different schools to complete a three page multiple choice questionnaire in order to precisely select and identify suitable participants for the study. From the twenty teachers a total of ten teachers who were suitable for the study were chosen. Suitable participants had to be teachers qualified to teach mathematics, teachers teaching in the FET phase mathematics and more precisely teachers currently teaching Grade 10 mathematics. The ten teachers selected to be participants for the study were targeted for the final sample. From the targeted final sample a total of seven teachers agreed to participate in the study which made up the final sample.

Thereafter teachers teaching two statistics lessons were to be observed following the observation schedule. Some of the lesson observations were video recorded and the others were observed by taking notes following the observation schedule since not all the participants agreed for their lessons to be video recorded. According to Cohen, Manion and Morrison (2011) a researcher becomes part of the data to be obtained by being physically part of the process. The researcher made use of video recording and non-video recordered observations of the lessons to confirm how teachers teach statistics and what methods they use to teach statistics at Grade 10 level.

Finally, a semi-structured interview was conducted based on the lesson observations. The teacher interviews were used to follow up on the lesson observations. The interviews were used to gain clarity and additional information which may not have been obtained from the

questionnaire and observations. The data collection in this study adhered to the following data collection plan.

Table 1: Data collection plan

Research question	**Instrument**	**Participant**
What methods do teachers use when teaching statistics in Grade 10?	Questionnaire and observation	Grade 10 mathematics teacher
How is statistics taught in Grade 10?	Observation	Grade 10 mathematics teacher
Why are these methods being used by teachers to teach statistics in Grade 10?	Observation Semi-structured interview	Grade 10 mathematics teacher

A questionnaire, observations and interviews were conducted with teachers who were teaching mathematics in the FET phase. According to Cohen, Manion and Morrison (2011) methodological triangulation is collecting data using multiple methods on one particular aspect of study. Kuper Reeves and Levinson (2008) further claim that using the triangulation method allows the researcher to use multiple methods which helped to produce more comprehensive data. In this study triangulation was achieved through asking participants to complete a multiple choice questionnaire based on their profiles, observe the participants while teaching their lessons and finally interview the participants based on the observations. The use of these three instruments formed the triangulation methodology and more precisely facilitates the verification of the different data collection instruments. This method allowed the researcher to obtain data directly from participants more rapidly. The different instruments provided more value towards the data collection.

The schools targeted were schools with more learners who chose mathematics as opposed to mathematics literacy in Grade 10. Grade 10 level was chosen specifically since most of the learners opt to choose mathematics whereas at Grade 11 and 12 there are fewer learners doing mathematics. Due to the complexity of the content in mathematics the learners tend to drop out at Grade 11 and 12 level. Therefore a total of twenty teachers, two teachers per school were invited to participate in the study; however not all the teachers taught Grade 10

mathematics. As a result only ten teachers were found to be suitable participants, however only seven from the ten suitable participants agreed to be participate in the study. Hence, seven teachers from the seven different schools were then identified as participants for the study.

The researcher personally took the questionnaires to the participants to ensure that questionnaires reached the identified teachers and the correct participants received the questionnaires and to remind participants not to put their names on the questionnaires. Personally handing questionnaires to participants enabled the researcher to discuss the collection of the questionnaires and the next phase of the data collection process. It also allowed the researcher to develop a sound relationship with the participants, ensuring the likelihood of receiving valuable data for the research study. Bell (2005) supports the idea of personally delivering questionnaires as it strengthens the working relationship in a positive manner with the participants, minimising a low rate of return and responses. The criteria used to select suitable participants for the study was based on their responses from the questionnaire. The responses expected were teachers qualified to teach mathematics, teachers teaching FET mathematics and more precisely teachers currently teaching Grade 10 mathematics. The questionnaire also allowed the researcher to obtain information about the methods teachers use when teaching statistics in Grade 10. The questionnaire contained multiple choice questions consisting of closed questions with possible answers provided.

Subsequently an observation was done of statistics lessons being taught by each of the seven teachers identified as suitable after the analysis of the questionnaires from the identified schools. Five teachers granted permission for their lessons to be video recorded and two teachers not in favour of their lessons being observed with the lesson observation being transcribed. The lesson observations were conducted at a prearranged time and date with the participating teachers, thus ensuring that they planned and prepared their lessons adequately and that arrangements made were in consultation with the school. An observational schedule was used in the classroom observations of both the video recorded lessons and the lessons that were not video recorded. The aim of observing the lessons was to capture the methods that teachers use when teaching statistics in Grade 10 and to see how statistics is taught in Grade 10. The observation process allowed the researcher to obtain the data required for the study more rapidly and in more precise detail. The observations allowed for a good

comparison amongst all the teachers who were observed. Furthermore, it identified and appreciated incidents that teachers may display in the teaching of statistics.

Finally, a semi-structured interview was conducted for the researcher to gain clarity on the observation as well as confirm what took place in the observation. Therefore the semi-structured interview confirmed the factors that led teachers to select the methods they use when teaching statistics, simultaneously the researcher received answers to the study that had not been answered adequately in the observations and questionnaire. Such as a semi-structured interview, according to Wilkinson and Birmingham (2003), allows the researcher to direct the interview more closely in clarifying and receiving answers to the research questions of the study which have not been adequately obtained. Therefore according to Struwig and Stead (2003) the interviewees' responses maybe influenced by pre-planned and predetermined questions. Furthermore, Wilkinson and Birmingham (2003) suggest the format and ordering of the questions in the semi-structured interview are driven by the responses of the interviewee to the directed questions. This will allow the researcher to structure the interview towards clarifying issues documented during the observations.

After the data collection is completed, each participant will be invited to a discussion and information session. At this session the researcher will discuss the findings and implications of the study with all the participants.

4.5 Pilot study

The instruments used to conduct the study, together with the methodology of the research project, play a crucial role in the data collection process therefore piloting the instruments to be used is of immense importance. According to Cohen, Manion and Morrison (2011) piloting the instruments is significant with pre-testing being crucial in their success. It strengthens the validity and reliability of the research instruments and data collection process. The occurrence of piloting the instruments took place in the researcher's present school which was suitable as it was not going to be part of the study with the results being excluded in the study. The pilot was conducted before the time the data collection process could commence. The necessity of the pilot study was to pre-test the instruments before the data collection, in order to allow provision for corrections and modification. Furthermore, the way in which the questions were worded and phrased needed an input from the respondent; this was a guide for the researcher to make necessary improvements.

The main objective of the pilot study was to determine whether the instruments were credible enough to answer the research questions, also investigating if the questionnaire is able to target suitable participants for the study. The responses from the interview assisted in redirecting and adjusting the questions from the interview schedule. An adjustment arose from both responses being similar, indirectly indicating the questions were similar requiring a similar response. Therefore the interview schedule was edited providing assistance in maintaining reliability and validity of the research. After careful consideration with the short falls of my instruments, they were improved and modified for the study and the data collection process to take place.

4.6 Sampling

Purposive sampling was used in the study as the researcher had criteria set out in the selection of suitable candidates for the study. Therefore this study used qualitative research which most often employs purposive sampling. According to Kuper, Reeves and Levinson (2008), one of the vital decisions in a qualitative study is identifying who to include in the sample, who to interview as well as who to observe. Onwuegbuzie and Leech (2007) add that sampling is an essential step in a qualitative research process. According to Cohen, Manion and Morrison (2011) sampling is a process of decision-making about the population (teachers) settings and lessons to observe, with a sample being a subset of the population; in this study the sample of mathematics teachers teaching Grade 10 and not the entire population of teachers teaching mathematics. Devers and Frankel (2000) claim purposive sampling strategies are designed to increase the understanding of identified individual's concepts, ensuring the sample is not too large or too small. According to Guarte and Barrios (2006) purposive sampling allows the researcher to depend on his or her judgment and experience. Furthermore, this type of sampling was based on the researcher's decision in the choice of participants.

In qualitative research, according to Creswell (2003), purposeful sampling involves selecting participants who are knowledgeable in what is to be investigated. Therefore more interpretation was applied upon the gathering of data. The researcher carefully chose a particular sample for the study as a qualitative study, according to Struwig and Stead (2007), focuses primarily on the value of the data. A convenient sample of Grade 10 mathematics teachers was chosen to explore the teaching of statistics in Grade 10 mathematics. According to Devers and Frankel (2000), a real world context is chosen in qualitative research and is carried out by identifying and negotiating access to the research site. A sample of ten

different high schools from the Durban South Region was identified as being suitable for this study. From the schools chosen, twenty mathematics teachers teaching mathematics in the Further education and Training phase were targeted and thereafter based on their responses to the questionnaires. The participants targeted for the study were to have at least a mathematics qualification in teaching mathematics.

4.7 Reliability, Validity and Rigour

In order to ensure the research study is successful it needed to be valid with all necessary measures and precautions taken to ensure validity within the research study. Validity is a significant factor in effective research, however without validity; Cohen, Manion and Morrison (2011) conclude that the research will be considered meaningless.

According to Rolfe (2006) validity within a study is achieved through consensus on each individual study as opposed to the researcher adhering to predetermined criteria in achieving validity. The validity of this study arises from the meaningfulness of the findings of the study so that credibility is linked to the results, whereby each individual study is given merit and praise individually with the methodological approach it employs. Bashir, Afzal and Azeem (2008) describe validity in a qualitative research as data that is credible and trustworthy which can be defended upon being challenged and criticised and reliability and validity being the two concepts in obtaining rigour in qualitative research. The researcher added valuable effort and quality data to the research study in order to obtain credibility, reliability and validity.

The instruments were piloted with the purpose of determining the suitability of the data collection and instruments. To ensure validity and reliability, transcripts were read by participants to ensure that what is on the transcripts is correct and that data is captured precisely by the researcher. This was done to avoid any misconceptions or misunderstanding in how the researcher has captured the data collected. Reliability, according to Struwing and Stead (2007), is similar to consistency as consistency allows room for reliability to be repeatedly displayed in the outcomes. To ensure consistency in validity and reliability are conformed to in the study, honesty as guidance in the data collected should lead to a valid, reliable and successful study.

This study made use of a triangulation of methods to interpret the human behaviour of the participants concerned. Struwig and Stead (2007) suggest that triangulation is the use of one approach to research confirming the other by the use of multiple data forms. Three different methods of data collection were utilised in the study. Data was triangulated using multiple data forms during the data collection process. The use of multiple methods in gathering data to study a particular aspect of a human action is identified, according to Cohen, Manion and Morrison (2011) as a triangulation method. Struwig and Stead (2007) claim the use of multiple methods to gather the data needs to conform to each other in achieving similar results. The purpose of triangulation was to facilitate the verification of the different data collection sources.

These multiple methods were a questionnaire, observations and semi- structured interviews. The reliability of the questionnaire was determined by identifying a teacher who was teaching mathematics in the FET phase at Grade 10 level and was considered suitable for the study. The observation was considered reliable when the researcher observed the teacher teaching the targeted grade and finally when the researcher conducted the semi-structured interview with the teacher based on the observation. Triangulation also increased the credibility and validity of results in a qualitative study ensuring accuracy in the information captured in the data collection process. According to Cohen, Manion and Morrison (2011) a methodological triangulation uses different methods on the same object of study which were appropriate for this study. The role of triangulation in qualitative research is ensuring reliability and validity within the study. Bashir, Afzal and Azeem (2008) claim that using these multiple methods such as interviews and observations are consistent with the interpretive paradigm.

Bashir, Afzal and Azeem (2008, p.42) state "engaging multiple methods such as, observation, interviews and recordings leads to more valid, reliable and diverse construction of realities". These methods assisted in clarifying issues, measuring consistency in the participants' teaching and provided answers to the research questions in the study. Bashir, Afzal and Azeem (2008) claim that triangulation is a strategy adopted in order to strengthen and improve the validity and reliability of the research study. Therefore using the above mentioned multiple data collection instruments allowed for an in depth clarification and understanding of the study.

4.8 Ethical consideration

An informed consent letter was given to each participant explaining the reasons and purpose of the study and explicitly informing and assuring participants that their involvement is voluntary and that they could freely withdraw from the study at any time, with their decision not being prejudiced or having negative repercussions. Pseudonyms were used to ensure that participants' identities remained confidential and that all responses were strictly confidential and all ethical protocol and procedures were followed at all times.

The principal and the school governing body were also informed through a consent letter explaining the nature of the study and emphasising that there will be no disruption in the school and the identity of the school will not be revealed. According to Devers and Frankel (2000) this is done to provide assurance as all gatekeepers share common concerns which include time, resources and disruption concerning the running of their organisations in participating in the study**.**

After the data collection was completed, each participant was invited to a discussion and information session. At this session the researcher discussed the findings and implications of the study with all the participants. All necessary procedures were followed in order to ensure ethical consideration for the research study was adhered to.

4.9 Conclusion

This chapter describes and outlines the research design and methodology used in the study including the data collection process. The sampling method is explained with a detailed description of the instruments used in the study. A thorough explanation of validity, reliability and ethical consideration in protecting the participants was addressed as the participants are the driving force of this study. The methodology used in this research is an interpretive research paradigm which employed a qualitative approach.

CHAPTER 5
DATA ANALYSIS

5.1 Introduction

The methodology chapter has explained how the research study was designed and how data was produced using multiple data collection methods. This chapter presents an analysis of the data collected from the teacher questionnaires, the classroom observations and the semi-structured teacher interviews. According to Hancock, Ockleford and Windridge (2009) analysis of data in a research project involves summarising the data collected and presenting the results in a way that will communicate the most important features. The purpose of this chapter is to outline the investigation carried out in relation to the instruments mentioned. Data from these instruments were analysed independently. The information was achieved using the methods described in the methodology chapter. This study intended to investigate the following critical research questions:

1. What methods do teachers use when teaching statistics in Grade 10?
2. How is statistics taught in Grade 10?
3. Why are these methods being used by teachers when teaching statistics in Grade 10?

As discussed in the methodology chapter, participants in the study were teachers teaching mathematics in the FET phase more specifically Grade10 mathematics. A total of twenty teachers were willing to complete the teacher questionnaire and a total of ten teachers were suitable, eligible and appropriate participants. However, closer to the observation process only seven teachers were willing and available. Therefore the final sample then became seven participants, nevertheless ten had agreed initially and due to the contents of Appendix 1 they were given the freedom to withdraw at any stage of the research. The teachers were selected as participants from their responses in the teacher questionnaire. The study was conducted using three instruments, a teacher questionnaire, observation and a semi- structured teacher interview. Each of these instruments had a crucial role in providing answers to the three critical questions used in this study.

5.2 Coding of the data

Data analysis is the most difficult and also most crucial aspect of qualitative research. According to Hancock, Ockleford and Windridge (2009**)** it is very important to be organised when keeping records of data. Coding, according to Basit (2003), is one of the important steps taken during analysis and serves to organise and make sense of data. It is common for qualitative researchers to analyse their own data. Furthermore Dey (1993) claims that coding data has an important role in analysis. It involves the organisation of data in order for thorough and appropriate analysis to occur; consequently codes were used as labels for allocating divisions of meaning to describe information compiled during the study. Struwig and Stead (2007) state that coding assigns meaning to the information obtained. According to Basit (2003) the significance of coding is to allow for data reduction, grouping and classification to take place. Therefore according to Cohen, Manion and Morrison (2011) coding data allows the researcher to discern similarities within the data in order to gain understanding on the compiled information. Basit (2003) reiterates that coding the data is an attempt by researchers to gain a deeper understanding of what has been collected and to continually refine their interpretations.

To safeguard the identity of the participants (teachers) involved, pseudonyms were used when referring to them. Codes enabled the researcher to identify the data obtained from the different instruments. Thereafter each instrument was grouped separately according to the research questions as each instrument was answering a particular critical research question within the study; with the different codes themes were developed**.** According to Miles and Hubernan (1994) qualitative research depends heavily on continuous analysis with coding being part of the analysis process.

Since coding is a process of analysis, the coding needed to follow a systematic process which could be easily accessible to retrieve information during the data analysis process. Coding the data made it easier, efficient and sped up the retrieval of data when it was being analysed. It was beneficial to ensure the code that the researcher created fitted into a structure that was meaningful and related to the study, by ensuring the codes were systematic in the way they represent the data collected.

5.3 Analysing the data

The analysis of data entails breaking down the information collected into elements in order to obtain responses to research questions and summarising the information achieved in the responses from the research questions. According to Cohen, Manion and Morrison (2011) qualitative data analysis involves the process of organising and being able to describe the data collected. It constitutes being able to present the data in a manner that is understandable whereby themes and categories are merged. Struwig and Stead (2007) state that data analysis methods allow the researcher to organise and add meaning to the large amounts of data collected**.** Qualitative data depends greatly on the interpretation of the particular research study. The data collected from this research study is derived from the teacher interviews that were transcribed and classified according to themes. Classroom observations were also analysed using themes, checking similarities and differences with the themes emerging from the interviews. In the view of Struwig and Stead (2007) the data interpretation should not deviate from the research aims. According to Flick (2009) in the interpretation of the data, thematic coding is applied as a multi stage procedure in comparing the analysis of the data.

A thematic analysis approach was applied in the analysis of the data in the research study. According to Braun and Clarke (2006) thematic analysis is a way to identify, analyse and report patterns (themes) within data. It involves understanding people's everyday experience of teaching in order to gain an understanding of their experiences. Thematic analysis can be a realistic method, which presents experiences, meanings and the reality of participants. In qualitative research the researcher triangulates the data collected from the various instruments. In this study, the sources were the questionnaire, the observation and the semi-structured teacher interview.

5.4 The Grade 10 teacher questionnaire

The questionnaire consisted of closed questions, used to gather only straight forward information about each teacher as it appears in Appendix 4. The questionnaire allowed for the researcher to obtain information about the methods and instructional tools teachers use when teaching statistics in Grade 10**.** The questionnaire contained multiple choice questions consisting of closed questions with possible answers provided. The researcher developed a questionnaire compromising of multiple choice questions with questions which required the respondent to pick an answer from a number of given options. The questions were chosen to

ensure the questionnaire was neither too long nor too short. According to Wilkinson and Birmingham (2003) a questionnaire can be easily and quickly analysed once completed. The questionnaire was used mainly to identify and select suitable participants for the study before investigating the methods and instructional tools teachers use to teach statistics. A total of twenty mathematics teachers were invited and purposefully chosen and given questionnaires to complete. From a total of twenty teachers ten were selected as suitable and appropriate participants, there were five male teachers and five female teachers. However closer to the observation period when statistics was being taught at schools three teachers were unable to continue with the study. Therefore the final sample consisted of seven participants made up of four female teachers and three male teachers.

A table representing race, gender and teaching experience of the participants in the research study.

Table 2: Gender, race and teaching experience of participants

Participant	Race	Gender	Number of years teaching
Sam	African	Male	6
Nana	African	Female	4
Zack	Indian (Asian)	Female	18
Mary	Indian (Asian)	Female	10
Pat	Indian (Asian)	Male	28
Rodney	Indian (Asian)	Male	12
Ben	Coloured	Female	26

The schools in which these teachers taught also varied according to their classification in terms of race, location and school grouping in terms of resources. It was also observed that the teachers selected were firstly qualified to teach mathematics, currently teaching mathematics in the FET phase and more precisely teaching Grade 10 mathematics at the time.

The participants' varying years of experience was taken into consideration to ensure that consistency and reliability existed in the data collection process. Teachers were categorised on a scale of 0- 5 years, 6- 10, 11- 20 and lastly 20 plus years. Each category had at least one teacher within that particular stage of experience. Furthermore, it was evident in the teachers' responses from the questionnaire that they had very little or no training during their pre-service training in statistics. It can be concluded from the analysis that more than half the

teachers did not have the necessary training to teach statistics. Therefore their experience and training on the topic of statistics was crucial in the selection of participants.

Since the questionnaire investigated the methods teachers used, it was practical for the questionnaire to include questions on the methods they prefer and are familiar with when teaching statistics and so teachers provided the information on the methods they prefer to use in the teaching of statistics. The questionnaire further enquired about the instructional tools they preferred to use when teaching statistics within the mathematics classroom. Their responses indicated that the traditional tool of the chalkboard was most popular, closely followed by the textbook. The other participants also indicated the use of worksheets and discussions. It is important to mention that teaching resources are able to assist teachers in developing creative learning environments in the classroom. The selection of appropriate teaching resources is important for teachers in imparting knowledge to learners so that the knowledge has a positive impact in their learning.

5.5 Analysing the classroom observations

From the observation schedule, teachers were observed teaching statistics lessons from the identified schools. Five out of the seven teachers' lessons were video recorded as they were comfortable and agreed for their lessons to be video recorded. Two out of the seven teachers who took part in the study were not in favour of their lessons being video recorded. Thereafter, the observation schedule was followed in detail and the lesson observation was transcribed. The researcher observed the lessons of those teachers who were not in favour of being video recorded by transcribing all the events with the guidance of the prepared observation schedule.

The aim of video recording the lessons was to capture the methods that teachers use when teaching statistics in Grade 10 in more detail because the researcher is able to refer back to certain events. The purpose of observing teachers involved in teaching was to gain a deeper insight and understanding of their practices. The observation of teachers teaching during a lesson was conducted without interfering with the actual teaching taking place in the classroom. This method was chosen with the purpose of helping the researcher to gain more insight and watch various teachers teaching in order to gain good comparisons. It was important for me to observe teachers' teaching strategies because one of the critical questions is to investigate how statistics is taught at Grade 10 level.

In the teaching of Grade 10 statistics the requirements are stipulated according to the current CAPS for Grades 10 – 12 in South Africa (DoBE, 2011), which has been implemented since 2012 in Grade 10. This current CAPS document requires teachers to adhere to the following work schedule when teaching statistics at Grade 10 level.

Table: 3 Work schedule Grade 10 mathematics

TOPIC	**CURRICULUM STATEMENT**	**SUGGESTED DURATION; START AND FINISH DATES**
STATISTICS	Revise measures of central tendency in ungrouped data. Measures of central tendency in grouped data: calculation of mean estimate of grouped data and identification of modal interval and interval in which the median lies. Revision of range as a measure of dispersion and extension to include percentiles, quartiles, interquartile and semi- interquartile range. Five number summary (maximum, minimum and quartiles) and box and whisker diagram**.** Use the statistical summaries (measures of central tendency and dispersion), and graphs to analyse and make meaningful comments on the context associated with the given data.	8 DAYS

In analysing the classroom observations, the work schedule (see table 3) was used to ensure that the teaching was in line with what was required to be taught, enabling the study to be valid. While analysing the classroom observations, I was also able to observe that the teaching that took place adhered to the requirements of the CAPS document. Hence, I find it

appropriate to unpack the requirements before going into detail into the analysis of the classroom observations.

5.5.1 The implementation of the work schedule for teaching statistics at Grade 10 level

The work schedule demonstrates that when a teacher teaches mathematics in the classroom, he/she is not merely an FET mathematics teacher but a mathematics teacher, therefore the work schedule (see table 3) is clear that the teacher needs to revise concepts taught in previous grades. This is a process of progression; progression within the mathematics curriculum is the process of linking the different concepts. These concepts are intertwined with each other rather than being separate ideas. For this reason, the content is grouped under broad headings, not presented through a single connection with individual experiences and outcomes. Through the learning and teaching which is planned, teachers are able to ensure that learners understand the connections between the concepts in order to support the development of their mathematical thinking and skills. Taking into account what has been taught in previous grades, prior knowledge needs to be reinforced. Furthermore, what the previous teacher has not taught in primary school and the GET (General Education and Training) phase, the teacher at hand should be capable and should teach those concepts by revising them with the learners. Qualified and well experienced teachers are allocated to teach the FET phase forming the Grade 10 -12 level, implying that these teachers have adequate knowledge to enable learners to achieve.

According to Shulman (1986), pedagogical knowledge is knowledge based on how to teach. A teacher also needs to have content knowledge in order to impart that knowledge. Therefore teachers should possess PCK which is a blend of content and pedagogy, where pedagogy is the transferring of knowledge**.** Therefore teachers should possess subject matter knowledge for teaching mathematics; teachers should not mistake the teaching of mathematics to solving problems as a mathematician. Howe (1999) claims mathematics at university and their courses are designed for professional mathematicians and technical users of mathematics and are not in line with the needs of teachers. Therefore teachers should have expert knowledge of teaching mathematics. Teaching is precisely the transformation of one's personal understanding of the content, so the knowledge of teaching mathematics is vital in the teaching process.

In order for transparency to prevail, the observation schedule was made available to participants prior to the lesson observations, to give participants an opportunity to make comments about what would be observed during their teaching. This was also to reduce any fears or tensions teachers might have of being observed. It was important as the researcher to capture information in a "live situation" and be part of the observation. Therefore the video recorded lessons were recorded in conjunction with making notes of incidents that were not covered in the research instrument, for example, teachers' reaction and response when they realise they have made an error. All participants, except one, were observed for one lesson only with five participants having granted permission for their lessons to be video recorded and two not granting permission. The two participants who did not grant permission for their lessons to be video recorded were observed by the researcher by taking notes of what transpired in the lesson with the guidance of the observation schedule.

Each teacher was allocated a code which represented the collection of data from them. The code was a label allocated to them which represented the data pertaining to them. The teachers who granted permission to be video recorded allowed for the researcher to collect a vast amount of data and allowed the researcher to keep watching the video recording when needing clarity on the data collected. The observation was designed to be video recorded to capture maximum data and correlate to the observation schedule. However not all participants were comfortable to give permission for their lessons to be video recorded.

5.5.2 The classroom and learning environment

In most cases the teachers' classrooms were not considered specialist rooms for the subject mathematics for example; life science and physical science classrooms are classified as specialist rooms because they have laboratories. It was up to the teacher to create an environment conducive to mathematics learning. Most teachers had charts and demonstrations but nothing that demonstrated the newly implemented topics in the mathematics curriculum such as statistical information.

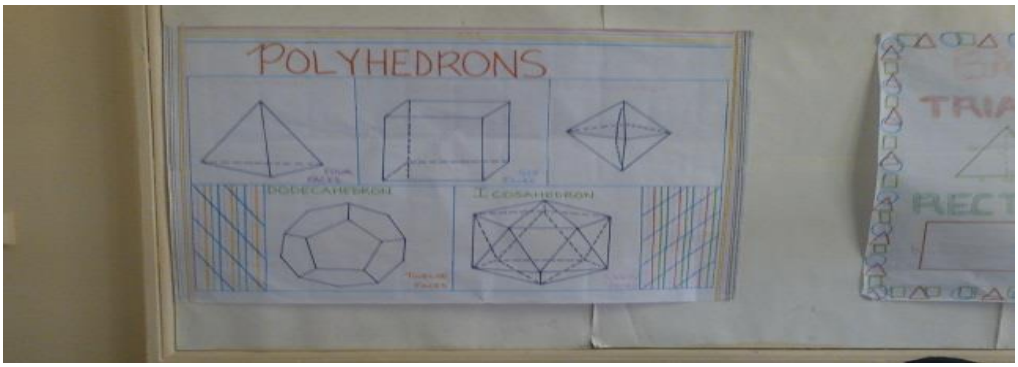

Figure 1: Classroom and learning environment of Watermelon Secondary

Only one teacher out of all the seven teachers noticed that the observation schedule aimed to see if any charts were displayed for the different topics. Thereafter the other participants created charts and displayed them, in order for them to be used when they were teaching to reinforce the content. The classroom sizes were large at all schools and there were no less than 20 learners in a classroom. A variance of the learners was looked at in terms of gender except for one school which had one gender only. Therefore the learning environment was analysed in detail.

5.5.3 The introduction of the lesson

How each teacher introduced the lesson was closely observed, taking into consideration how the teacher related to the learners and the methods used by teachers to attract the learners' attention and unpack the concept being taught on that particular day. This was accomplished through the use of varies methods used to teach statistics such as: brainstorming, discussion, demonstration, lecture or presentation and independent study. Before the lesson began great discussion, demonstration and brainstorming took place in order to draw the learners' attention and focus on the topic of statistics. This permitted the learners thought process to be directed towards statistical thinking. Allowing for the learners participate in the lesson and understand the importance the topic at hand. The examples the teachers used to introduce the lesson were significant in that they relate to the introduction and attention of the learners. The learners' responses to the teachers indicated the outcome in the introduction of the concept as the examples used needed to be appropriate to the learners being taught. The examples used allowed for meaningful learning to take place. The examples that teachers used integrated the content and learners environment.

5.5.4 The development and structure of the lesson

The way in which the teacher unpacked the topic was crucial as momentum was developed in the lesson. A successful introduction creates interest in the learning environment. The

methods which the teacher used were also important as the learners learn in different ways and the choice of methodology also creates understanding in the learners depending on the topic. The implementation of the method demonstrated the teachers' understanding of his or her learners' capabilities and potential to know which method is most appropriate to teach statistics. The type of examples the teacher used to reinforce the concept being taught at hand allowed the learners to relate to the example and therefore the concept was significant. The teaching needed to equip the learner for beyond the classroom in order for him/her to benefit in the outside world. Each teacher used a different method to reinforce the concept being taught.

5.5.5 Conclusion of the lesson

How the teacher was able to consolidate the concepts taught and concluded the lesson was observed closely. This included the homework given and the type of examples provided to reinforce the concepts taught within the lesson. The homework incorporated the content taught in order to evaluate the learners understanding and application of the concepts taught. The types of examples used to generate the data were used to assess the content delivered and were relevant to the learners in that particular class.

5.6 Analysing the teacher interviews

The semi-structured interview was used by the researcher to gain clarity on the observation as well as confirm what took place in the observation. Therefore the semi- structured interview was used to confirm the factors that led teachers to selecting the methods they used when teaching statistics and simultaneously the researcher received answers to the study that had not been adequately obtained in the previous instruments which are the observations and questionnaire. According to Wilkinson and Birmingham (2003) a semi- structured interview allows the researcher to direct the interview more closely in clarifying and receiving answers to the research questions of the study which have not been adequately obtained.

The purpose of the teacher interviews was to investigate any questions that may not have been answered in the teacher questionnaire and teacher observation that require first hand responses. The teacher interview also provided an opportunity for the participants (teachers) to have a voice within the research, mainly to gain understanding as to why these methods are being used by teachers to teach statistics in Grade 10.

The themes that emerged from the observations and confirmed from the semi-structured interviews with teachers were: what methods did teachers use, why did they use these methods, the changing of methodology, factors that guide the choice of methodology, the way teachers teach statistics, the way teachers choose the examples and the examples they use and lastly teachers' opinions of statistics.

The majority of teachers preferred using different innovative methods complemented by the different instructional tools used to teach statistics, which entailed the use of the chalkboard, textbook, worksheets and power point presentations to emphasise the concepts and workings. Although the teachers used different instructional tools they still resorted to the chalkboard because it was at their disposal, while taking into account that the chalkboard is one of the more popular instructional tools used when teaching.

Hence, the majority of teachers found value in the use of the chalkboard, since it was effective in their learning**.** The majority of the teachers were of the belief that every topic was associated with a particular method because every topic is different. The choice of methodology was greatly dependent on the topic to be taught. Consequently, it was clear that the teachers changed their methodologies depending on the topic**.** It was not only the topic but a number of other factors that had an influence in the choice of methodologies. The factors that influenced the methodology were crucial during the process of planning. The factors which many teachers mentioned were the caliber of learners, resources in the school and the time that was allocated to teach the topic within the framework of the work schedule (see table 3), as time plays a crucial role in the choice of method to be used.

5.7 Conclusion

This chapter presented an analysis of the data collected by demonstrating the importance of each instrument used within the research and how these three instruments have contributed in answering the three critical research questions. The process of analysis of data is described in this chapter. The next chapter will deal with the findings and will conclude with some recommendations based on this study.

CHAPTER 6
FINDINGS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the findings and recommendations based on the data collected from the teacher questionnaires, the classroom observations and teacher interviews. The purpose of this chapter is to report on the findings based on the instruments mentioned. Thereafter the findings are summarised and recommendations are given. The purpose of this study was to explore the teaching of statistics at Grade 10 level. In order to achieve this, the study adhered to the following critical research questions:

1. What methods do teachers use when teaching statistics in Grade 10?
2. How is statistics taught in Grade 10?
3. Why are these methods being used by teachers when teaching statistics in Grade 10?

The methods that teachers used when teaching statistics were captured through the teacher questionnaires and the observations that took place. How statistics is taught at Grade 10 level was determined through the observations. Furthermore, the reasons why the participants used these methods to teach statistics at Grade 10 level were obtained through the teacher semi-structured interviews. The study focused on exploring the teaching of Grade 10 statistics, placing emphasis on the teacher and the teaching process. The teaching methods that were selected by teachers were more teacher centred because the focus of the study was on how the teacher teaches the topic statistics at Grade 10 level. It is significant to note that innovative methods were used to teach statistics such as brainstorming, discussion, demonstration, lecture or presentation and independent study. These methods were supported by the use of appropriate instructional tools such as mainly the chalkboard, worksheets, textbooks and technology which incorporated the use of power point**.** The use of the chalkboard came naturally, especially when teachers were emphasising concepts since it was at their disposal.

The chalkboard was used as an appropriate instructional tool in conjunction with the different methods to reiterate the concepts and content that was taught within statistics. The methods that participants chose varied according to reasons and circumstances depending on the

situation with which they were confronted. The participants individually had unique situations and factors to deal with considering each school is different. However in order to ensure quality teaching prevailed to benefit the learners, participants resorted to methods that were best suited for the situation.

6.2 Instructional tools employed by participants

Every participant had his or her own preference in terms of the method to use supported by the different instructional tools. Participants used the following instructional tools to teach statistics: chalkboard, textbooks, worksheets and technology based teaching.

Table 4: Instructional tools used by participants to teach statistics

Participant		**Instructional used by participants**			
Observation code	School code	Chalkboard	Textbook	Worksheet	Technology based teaching
SO	Mov	√		√	
NO	Aov	√	√		
MO	Lov	√	√	√	
PO	Pov	√		√	√
RO	Gov	√			
BO	Wov	√	√		√
ZO	Bov	√	√		

The above table represents instructional tools that were used by the participants when their lessons were observed. There were a total of seven participants and each used the instructional tools as indicated in the table above. Each of the participants taught differently and made use of different instructional tools in order to support their method of teaching with each concept being explained and taught using different methods. The measures of central tendency were taught using a discussion, presentation or demonstration method. Since these concepts required an understanding of how they are used in the content as well in the real world. This is when the teacher introduced real life scenarios such as teenage pregnancy, speed on the national roads, test results, diseases, shoe sizes, clothing and mode of transport used to school by the learners. Where by a discussion and presentation was used to demonstrate the significance and the use of statistics within our society. For example, an article was brought to the classroom to demonstrate, discuss and present the statistical report based on teenage pregnancy. According to Mlambo (2015) “the shocking statistics have prompted calls for guidance counsellors to be reintroduced at school”. This relates content to

the learners' context enhancing their understanding and relevance of the topic statistics. These examples were educational in informing learners the repercussions of teenage pregnancy and guidance on how to prevent teenage pregnancy.

The participants who responded to the questionnaire claimed to use different methods incorporating different instructional tools. When the observations took place, it was evident that when the participants taught statistics they used a variety of methods yet still resorted to the use of the chalkboard in order to emphasise the content and to reiterate important concepts. It was interesting to note during the observations that participants were creative in creating exciting learning environments in order for effective teaching to take place**.** The type of examples that were used within the lessons, were applicable to the learners being taught. The relevance of the data and examples used created participation and lead to interesting discussions to reiterate the content being taught. It also provided an opportunity for the learners to use their discretion in the examples used, where an open question was provided to give a motivation as to how they arrived at that particular answer and conclusion. These examples provided the learners with answers to real world situations that they are faced with on a daily basis. The methods that were incorporated were discussions and brainstorming. The participants' creativity in the methods used was beneficial to the learners in that learning took place encouraging participation and critical thinking. The discussions and brainstorming that took place involved realistic and real world scenarios. According to the observations it was clear that the traditional 'chalk and talk' teaching method was most popular and valued, since all the participants made use of the chalkboard. The second most popular instructional tool was the use of the textbook; followed by the use of worksheets and lastly participants' utilised technology based teaching through the use of the data projector and power point presentations to teach statistics. These instructional tools supported the methods used to teach statistics such as brainstorming, discussion, demonstration, lecture or presentation.

During the observations there was a clear indication that teaching resources used as instructional tools enabled participants to develop creative learning environments in the classroom. The selection of appropriate teaching resources or instructional tools is important for participants in imparting knowledge to learners which has a positive impact in their lives. Similarly**,** Killen (2000) notes that a teacher is responsible for presenting information in ways that facilitate learners' understanding.

6.2.1 The use of the chalkboard

All seven participants in this study used the chalkboard in their classroom mainly to emphasise the concepts and to display the solutions. The chalkboard was not the first choice for all the participants, besides only one participant used the chalkboard as his primary instructional tool which is closely linked to the lecture method. When Rodney was questioned why he preferred the 'chalk and talk' method which lends itself to the lecture method he claimed that:

RI: "…*The chalkboard works perfectly well for me because the numbers and data are made up by me. So I do the application, the methods and workings on the chalkboard…"*

This is supported by Scheafter and Emesitur (2004) who describe statistics as numbers in context which normally is referred to as data.

Figure 2: The use of the chalkboard by Rodney from Grape Secondary

Figure 3: Rodney's preferred instructional tool, from Grape Secondary

There were similar teaching methods amongst the teachers in the observations. All the participants in the study used the instructional tool of the chalkboard with the intention to reiterate concepts within the topic. At some point in the lesson the participants made use of the chalkboard. When asked why he preferred the use of the chalkboard, these are some of the responses:

NI: "…*the chalkboard and textbooks work well for me because the numbers and data are already in the textbook. So I do the application and solutions on the chalkboard…"*

According to Becker and Watts (2001) it is easier to gain the attention of the learners by using the chalkboard as opposed to using only the textbook. In the view of Evertson, Emmer and Brophy (1980) the more time spent with the class increases the participant's opportunity to provide more examples to elaborate important concepts and misunderstandings before they undertake application exercises. The examples used to reiterate concepts had to be appropriate at all times. It had to be examples that they were familiar and aware of for example, shoes sizes. This example was chosen very carefully and with reason as every learner in the class is familiar with shoes and sizes; this example was definitely appropriate and relevant. This gave an introduction to the topic of statistics and its relevance in the mathematics curriculum. The "chalk and talk" traditional method in most cases is time consuming as writing on the chalkboard is time consuming, additionally learners take a long time to copy the notes from the chalkboard.

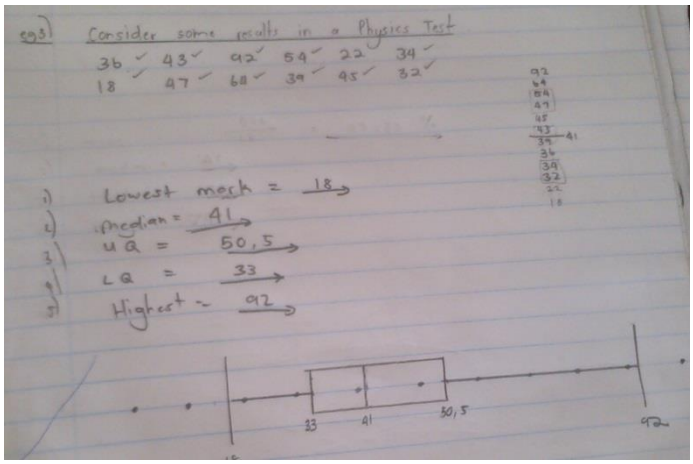

Figure 4: Evidence of work copied from the chalkboard by a learner from Banana Secondary

Some challenges experienced by using the chalkboard included: writing notes on a very limited amount of chalkboard space, learners copy the incorrect content from the chalkboard; in addition, all the taught content cannot be displayed on the chalkboard. Furthermore the choice of teaching method and instructional tool is determined by various factors and when the participants were asked to indicate some of the factors that determine the choice of their teaching methods and instructional tool, their responses were:

SI: "…*sometimes it gets too much for the teacher to write all the data on the board, therefore I have to resort to the discussion method where I'll make use of worksheets as one of the instructional tools then reiterate on the chalkboard…"*

PI: "*…on power point incorporating a variety of methods which are discussions, brainstorming, demonstrations and presentations you able to display a lot of information that cannot be displayed on the chalkboard…"*

Based on the lesson observations it was apparent that the chalkboard was very useful when explaining the different concepts thoroughly. In this study, the use of the chalkboard provided active engagement and interaction between the participant and the learners. Participants are often forced to use the chalkboard as it is the only resource available in the classroom. It is valuable in that it allows for the participant to elaborate on certain concepts whereby the participant gets the entire class to pay attention to one focal point. According to Becker and Watts (2001) the use of the chalkboard is effective and cost effective in order to cover many topics and concepts in a limited amount of time. The majority of South African classrooms have a chalkboard or a smart board which is the focal point in the classroom. The participant is the mediator in the classroom and the textbook; worksheet, power point and chalkboard cannot interpret or unpack the content to make it simpler or easier to understand. So these innovative methods supported by the chalkboard as an appropriate instructional tool play an important role in the teaching of mathematics, more precisely the teaching of statistics at Grade 10 level.

6.2.2 The use of textbooks in the classroom

The participants were of the opinion that using a textbook makes teaching more efficient and saves time when teaching the lesson. The National Department of Education has allocated funds to purchase textbooks for learners. According to the Department of Basic education (2015, p.4) "the learning and teaching support materials (LTSM) is improved and that we work towards one textbook per learner per subject in all schools." This was done to ensure that every learner had access to learning material. The textbook contains content dealing with the topic of statistics and makes the teaching of statistics much simpler with data and examples readily available. The textbook contains the concepts which are required for the topic statistics at grade 10 level.

According to Evertson, Emmer and Brophy (1980) the use of a curriculum aligned textbook as an instructional tool by the teacher is of great value in the teaching process. According to the Department of Basic Education (2015) they have made efforts to provide textbooks for each learner per subject and per grade. When participants were asked about their view of the

appropriateness of using textbooks as a teaching tool to support their methods of teaching, their responses were as follows:

NI: "*…the textbook has the data readily available and consolidated…"*
ZI: "*…I make use of the textbook as per instruction and recommendation by the Department of Education especially at present with the new CAPS syllabus in place…*"

The text book provides the learner with learning material to be used and is helpful when the teacher is away from the classroom, encouraging learners to work independently which is in line with the method of independent study. Using a textbook eradicates time wasting and the textbook offers more examples and application exercises to work through. This provided the learners with the opportunity to engage with the content they had been taught by applying their learning in the exercise. The participant at this point was able to address any queries and provide individual attention by moving around the classroom ensuring the learners engage in the tasks given. By walking around the teacher was monitoring the learners' progress and simultaneously assessing the learners, at the same time remedial intervention could be done and address any issues regarding understanding and misconceptions, however this also gave encouragement to learners who were correct and understood the curriculum to become motivated and gain confidence in the subject and their learning ability.

The textbook enables learners to work at their own pace, accommodating the different pace at which different learners work. The use of the textbook enables the teacher to make provision for all the learners according to their learning abilities. The examples and the content are arranged according to the cognitive levels of learning. This was evident in the following statement made by Nana.

NI: "… *using a textbook as an instructional tool caters for all types of learners*…"

Furthermore, a textbook provides learners with the opportunity to continuously work even in the absence of a teacher incorporating the method of independent study. According to the Department of Basic Education (2015) a textbook is an instrument used to ensure that learners cover all the topics they should cover within their current academic school year. A clear and transparent indication of the expectation of work to be done is provided for the

learner. Therefore pre - learning can take place prior to the topic being taught, In addition the use of the textbook encourages the independent learning method.

6.2.3 The use of worksheets in the classroom

Three out of seven participants used worksheets, as they found them appropriate and very useful within their lessons. One of the participants resorted to a worksheet as he felt that it maintained discipline, prevented learners from being disruptive and promoted participation amongst the learners. Discussions and brainstorming were the methods used in conjunction with the worksheet as an instructional tool. When asked why he specifically resorted to the use of the worksheet the participant responded as follows:

SI: "…*The worksheet was there so as to eliminate disruption and encourage participation in the learners. In the lesson I make the disruptive learners read the worksheet, I prepare for them to ensure good classroom management and maintain their attention in the learning process…"*

The worksheet is prepared for the learner with a combination from the different examples from different textbooks, since the textbooks provide the necessary content required and are intended to fulfil the requirements of the CAPS document. However not all the topics are presented in a way that fully satisfies the teacher, therefore a variety of textbooks are utilised in order to ensure the content taught is beneficial to the learner receiving it. The use of the worksheet consolidates content that ought to be taught in order to facilitate relevant and appropriate learning. A worksheet allows for a variety of examples and content to be used accommodating the teacher to implement brainstorming and discussion simultaneously within the lesson. It saves the teacher time, since the teacher does not have time to write on the chalkboard as he/she is governed by time allocated to teach each of the different topics. The use of a worksheet provides evidence of the work and consistency as it is pasted into the notebook. The worksheet accommodated the participant to incorporate the different methods in order for effective learning to take place as learners were given the opportunity to respond. This meant the teacher acted as a facilitator by guiding the learners in the right direction to encourage participation.

6.2.4 The use of technology based teaching as an instructional tool in the classroom

It was evident from the two participants who made use of technology based teaching as an instructional tool in their teaching that teachers are making use of technology in their teaching of mathematics. What was encouraging from the observations was that the two participants who used the power point presentations were the most senior in terms of age and teaching experience to all who participated in the study. Furthermore the schools that they taught in were not very well resourced yet they went the extra mile to include technology in their teaching. Considering that we are living in a society driven by technology, these participants found the use of power point presentations more advantageous compared to the other instructional tools in their teaching, such as the chalkboard, worksheets and textbooks when teaching Grade 10 statistics. According to Milito, Pannone and Luchini (2001) appropriate learning occurs when content, pedagogy and technology reinforce each other in a balanced manner. These participants indicated that the use of power point presentations captured the attention of the learners and additionally this instructional tool made the lesson exciting. According to Hooper and Rieber (1995), education using technology entails the application of ideas from various sources to create the best learning environments for learners. When the two participants were asked why they opted to use the technology based teaching method in their lessons their responses were as follows:

PI: "…*by the use of power point it makes the lesson more exciting…*"

BI: "…*it was not solely because of statistics, I have realised technology makes the lesson more exciting and easier to teach and also adapting with time …*"

Therefore the use of the technology as an instructional tool satisfied their teaching needs and kept learners' concentration at a maximum. Hooper and Rieber (1995) claim that interest is based on how technology allows the learners to engage with the content. The use of technology as an instructional tool brought reality to the learners and the participants were able to achieve what they intended. Leaners were able to identify with the instructional tool used by the participant as we are living in a technologically driven society. One of these senior participants Ben from Watermelon Secondary (Wov) made mention of having moved with the modern times and has now adapted to teaching using the technology in aid of supporting her teaching methods. The teaching methods that are closely linked to the use of power point and technology are presentations, lecture and discussions. When I asked Ben one

of the participants, why she used power point (Technology) as an instructional tool in the teaching of statistics, she responded as follows:

BI: "…*I am gearing towards the use of technology. It was not solely because of statistics, I have realised technology makes the lesson more exciting and easier to teach and adds value to the teaching* …"

Within the lesson observation these two candidates were able to display information on the screen which encouraged discussion, brainstorming and debates on the data presented. These methods encouraged participation of the learners within the lesson with the participant assisting the learners to address the conflicts in constructive ways. According to Wehrli and Nyquist (2003) it is beneficial to create a safe environment for learners to participate, ask questions and make mistakes without sanctions on their responses. According to Damodhharan and Rengarajan (2012) incorporating technology elements into the lesson allowed the learners to learn better and made them more motivated in becoming more attentive to the information presented and they consequently retained the information better.

Much information which is displayed through a presentation and lecture method on the screen cannot be displayed on the chalkboard and consequently, it saves time which could be dedicated to teaching. A power point presentation ensures that proper planning is done, since what will be on the power point presentation is what the participant has already prepared and understands. In the view of Hooper and Rieber (1995), the integration of technology in education using technology as an instructional tool comprises a variety of sources that creates a conducive learning atmosphere. By the use of technology as an instructional tool, more time is allocated to teach, explain and elaborate so that the learners gain necessary and maximum understanding. According to Damodhharan and Rengarajan (2012) technology is also changing the classroom experience. Teaching can be highly effective if the teachers use recent technologies like computers and calculators in their teaching since technology is growing at a rapid pace.

6.3 How is statistics taught in Grade 10?

In the teaching of Grade 10 statistics it was evident in the observations that participants found value in using the traditional 'chalk and talk' method which is the closely aligned to the lecture method. According to Jaki and Autin (2009) the traditional classroom instruction

consists of teacher-centred learning in which the teacher presents the content material through lectures. Even though other instructional tools were used, the chalkboard still had a role and contribution to learning during the teaching process. For successful teaching to take place in the classroom, it was significant that teachers possess adequate PCK which is a blend of content and pedagogy. However Batanero, Burrill and Reading (2011) pointed out that at present very few mathematics teachers have pedagogical training in statistics.

Garfield & Ben-Zvi (2008) claim teachers ought to develop an in-depth and meaningful understanding of statistics, so that learners obtain the ability to think and reason statistically. According to Milito, Pannone and Luchini, (2001) the teaching of statistics should emphasise the understanding of statistical concepts and methods encouraging the learners to acquire awareness of how important it is to be able to assess the mass statistical information they come across on a daily basis. The participants were all unique and taught different learners, therefore the way in which they taught the topic varied from one participant to another, since teaching is the ability to transfer knowledge. When a participant teaches, he or she imparts knowledge to the learners with the aim to convince the learners in re-organising their understanding. This idea was implemented by the use of discussions, brainstorming and presentation methods using different instructional tools.

The participant's choice in instructional tool varied as they were all faced with different circumstances, such as availability of resources in the schools, type of learners, behaviours of learners and the gender of the leaners. The choice of instructional tool was a decision taken by the participant and was dependent on the participant. Since the CAPS document for mathematics FET prescribes the content to be taught in statistics at grade 10 level. The participant had to utilise what was available and at their disposal in order to fulfill the prescribed requirement in the CAPS document to teach statistics at grade 10 level.

Revision of content taught in previous grades needs to be incorporated before proceeding to new content to be encountered at Grade 10 level. Prior knowledge should be a priority in ensuring that the grounding of the new content is properly taught. According to Killen (2000) teachers should relate new information to what learners already know and provide learners with time to think about new information. Stein and Ricket (1987) believe the structure of the mathematics curriculum is significant together with firstly teaching the basics. This was important for the learners' understanding of mathematics. Mathematics is an essential tool for

the teaching of statistics (Scheafter and Emesitur, 2004). According to Milito**,** Pannone and Luchini, (2001) the teaching of statistics, besides being incorporated in the mathematics curriculum is very often dealt with in an abstract and formal way.

However, teaching new content without revising previous knowledge is pointless, as the teaching will be unsuccessful. Mary, one of the participants, when questioned, which method she found most appropriate to use in teaching statistics and why, responded that:

MI: "…*the method I found most appropriate to teach the topic of statistics would be to explain and discuss the theory aspects of the topic first. This includes the definition, application and formulae that are involved with each sub- section of statistics…"*

It was useful to define and discuss the terminology that is used in the teaching of statistics to ensure that the learners have an understanding of the language used. Therefore, before teaching proceeds it was beneficial to the learners to ensure the concepts and terms are explained explicitly. The method that was aligned with ensuring terminology is explained explicitly is the discussion method. Killen (2000) is in support of the idea that teachers explain the meaning of new words. Although in mathematics terminologies are not defined and learnt for examination purposes, however, it was still useful to define the terms in order to increase understanding and improve the quality of teaching. This was practiced to prevent misconceptions that may arise in the teaching process. Statistics is a topic which entails the use of real world examples, therefore the type of examples that the participants use must be appropriate to the learners' environment. The choices of examples used were to reiterate concepts and were relevant to the learners being taught.

According to Killen (2000) teachers need to use appropriate examples when explaining and use examples from the learners' world. Examples need to be those that are related to their daily living and not unfamiliar examples as a lack of interest will set in. The examples that teachers used were very relevant to the learners, participants used examples such as: shoe sizes, pregnancy, sport, clothing, test scores and speed levels of cars. These examples were appropriate and relevant in that they were simultaneously educational for their daily living. According to Milito, Pannone and Luchini, (2001) working with real data reflecting a real life situation favours a better learning of statistical methods and develops learners interests, as

they are personally involved in the collection and interpretation of the data. The following examples were used by participants.

SO: "… *teenage pregnancy was a relevant example which many learners were aware of and could identify with providing them with the significance of statistics*…"

NO: "… *speed used on the national roads was applicable as learners were able to identify with it, since they have all travelled in a vehicle and are aware of the accidental reports which require statistics*…"

RO: "…*test results were very familiar since they are a part of the process and it made sense of how the data is used statistically*…"

PO: "… *the diseases that are out there and how they become noticeable and given priority to be treated is a result of statistical reports*…"

BO: "… *shoe sizes were appropriate with all learners making use of shoes which made sense of the role of statistical information in the manufacturing of shoes and sizes*…"

MO: "… *clothing that is sold out there and its relevance to statistics was used to reinforce the importance of statistics*…"

ZO: "…*the mode of transport that learners use to school in order to identify issues related to late coming made it relevant as to how statistics can be used…"*

The above examples used by teachers were not only applicable to the content of teaching the topic statistics, but educational and beneficial to their well-being. It was noticeable that the example of teenage pregnancy brought great attention to the learners. They were able to identify with the example, provide their views on the scenario. The teacher was able to provide guidance and advice pertaining to teenage pregnancy, not only to the girls but both genders. A demonstration of the significance statistics was presented with a newspaper article reporting of school pregnancy. Pertaining to speed on the national roads a discussion took place whereby the relevance of statistics was presented and its significance within the accidental reports that we receive every holiday and peak season. Test results were very clear as the learners are always presented with their test scores. This was relevant and applicable since they are continuously being presented with their statistical results. The content was relevant and educational in understanding the feedback they receive from the test analysis of their results. The example pertaining to the health diseases out there made meaning as to how they become popular and are a priority, which results from the analysis of the data and feedback they receive which is analysed statistically using the concept learnt within the topic of statistics. The shoes size and clothing example arouse great interest in the learners to

understand why the factor of shoes and sizes was significant and that statistics plays a vital role in the dynamics of something simple such as shoes and shoe sizes. A power point presentation was displayed for the learners to make sense of the example used to explain the concepts. This allowed for the learning of the topic to become more meaningful and applicable. Lastly the mode of transport that learners use to school brought attention as to how statistical thinking and content has an impact in their daily living. The role statistics plays within the choice of transport they use to school and as to how their choices are influenced by their understanding of statistical concepts as well as being statistically literate. These examples increased the learner's statistical knowledge and gained their interest in leading them to become statistically literate individuals. Allowing the learners to apply the content learnt within their different daily encounters.

The teaching of statistics involved the learners by ensuring the content related to their surroundings and was familiar and realistic to them. Similarly, Dörfler (2003) proposes that there is a relationship between mathematics and human beings, as mathematics is a human activity which deals with actual living human beings. North and Ottaviani (2002) suggest that mathematics teachers need to be empowered in how to link statistics and mathematics in order for the teaching of statistics to be successful.

Mathematics is not only for the classroom as it is seen every day, and the learning should relate to real life by bringing every day experiences into the classroom. Goulding (2004) believes mathematics is vital in everyday life as many forms of employment, science, technology, medicine, the economy, the environment and development in public decision making make use of the logical reasoning acquired in mathematics.

Similarly, Ediger (2002) suggests the use of examples that are related to everyday life is vital in the teaching of mathematics**.** Teachers should allow for the concepts to simmer by doing a thorough pedagogic process and avoid teaching through the solving of problems only. According to Wessels (2008) the study of statistics should not merely rely on formulae but should enable learners to engage with examples and experiences from the real world. When the participants taught statistics, it was noticeable that many methods and instructional tools were used. Problem solving, class discussions and presentations were used on a large scale for example problem solving was used during the application part of the lesson where the learner was applying what they have been taught. In terms of the class discussions it was

more related to recapping what was previously learnt since at each observation the concepts were different yet still dealing with the topic of statistics. Presentations in the study were used in conjunction with the technology based teaching since it accommodated the methodology.

Worksheets with real world examples, power point and lastly the traditional "chalk and talk" method were used to reiterate concepts. It was interesting to see how much effort the participants put into the planning of their lessons to ensure their teaching is successful, bearing in mind that their lessons had to be aligned with the Curriculum Assessment Policy Statement. This was clear by the flow of the lesson and the activities provided for the learners, the researcher being a mathematics teacher was able to make a conclusion that planning and effort was invested in the lessons. The researcher did not have to scrutinize the lesson plans as it was not part of the observation schedule, however from the observation it was clear that proper planning was implemented in conducting the lesson.

The learners' attention was captured by using relevant and appropriate examples to which they were able to relate. Discussions and presentations were utilised in order to ensure the interest of the learners was at a maximum. This encouraged participation and engagement with the learners. With the use of these methods the teacher was able to steer the learners in a direction where their answers were supported by valid and valuable conclusions integrated by the content. Statistics is generally taught by using real life data in order to create valid conclusions based on the data. The solutions are never the same yet the concept of arriving at a particular answer is the same, due to the data being aligned with different contexts and examples. Therefore the methods of brainstorming, discussions and presentations have a crucial role to play in the teaching of statistics supported by appropriate instructional tools. The instructional tools are closely related to the methods in order for the content to be unpacked and provide value in the method the teacher has chosen. The method chosen and instructional tool are driven by the type and nature of example used in order to deliver the concept of the content being taught.

One of the participants, Pat from Peach secondary had charts on the wall with the concepts of statistics drawn by him for the reference of the terminology used and to keep learners aware of the concepts, which was rare in all the other classrooms that were observed. This displayed creativity, empowerment, passion and experience. The use of various examples and methods was an attempt to achieve success in their teaching regardless of the circumstances.

The topic statistics was important according to the participants as the learners were able to see its significance in the real world. Consequently, when the participants teach statistics they were able to relate the content to the real world. The participants ensured that the learners identified the interconnection between content and its usefulness outside of the classroom. The participants had the ability to teach so that the learners were in a position to benefit within the real world and beyond school. According to Statistics South Africa (2013, p.1) the teaching of the topic statistics equips learners for the real word, so they are able to acquire the following concepts:

- **Collecting data:** including distinguishing between samples and populations.
- **Organising and summarising data:** using tallies, tables and steam and leaf displays; determining measures of central tendency (mean, median and mode), determining measures of dispersion (range, extremes, outliers).
- **Representing data:** drawing and interpreting bar graphs, double bar graphs, histograms, pie charts, broken line graphs and scatter plots**.**
- **Interpreting data:** critically reading and interpreting two sets of data represented in a variety of graphs**.**
- **Analysing data:** critically analysing data by answering questions related to data collection methods, summaries of data, sources of error and bias in the data.
- **Reporting data :** by drawing conclusions about the data; making predictions based on the data; making comparisons between two sets of data ; identifying sources of error and bias in the data; choosing appropriate summary statistics (mean, median, mode and range) for the data and discussing the role of extremes and outliers in the data.

This gives satisfaction to participants when teaching statistics as a topic which is interesting to both the participants and the learners and is beneficial to them in their daily lives. When a teacher has to teach a topic like statistics, it is difficult to isolate the content from an example. The examples were used to link the content in order for understanding to occur. So the participants had to be very selective in the examples they used as they have an impact on the teaching. When choosing examples participants had to consider many factors, such as the type of learners, learners' background, race and gender. The participant had to carefully consider all these factors when selecting an example to reiterate and ensure understanding of the content.

6.3.1 The learners in the classroom

The type of learners you teach determines the examples a teacher can use; their behaviour patterns, maturity and understanding are taken into consideration. The examples used had to be relevant and appropriate for the learners' age and maturity level. The types of examples had to be realistic and relate to their everyday encounters. When Nana, one of the participants was asked, what happens if the examples in the textbook do not relate to the learners, her response was:

NI: *"... I change the examples accordingly to suite the learners I am teaching..."*

The examples that are chosen need to be married with the content, so that it teaches them something for the present and the future. The teaching processes must be realistic and interesting to the learners. Rumsey (2002) claims that statistics in the school mathematics curriculum raises awareness of the data in everyday life**.** When the teaching is relevant to their daily lives they begin to take a greater interest in the learning process. Sam introduced data which pertained to teenage pregnancy since the class was made up of teenagers. This example was relevant as it brought out awareness of the importance of statistics. According to Mlambo (2015) "the shocking statistics have prompted calls for guidance counsellors to be reintroduced at schools and for a clear intervention policy to be implemented by national and provincial education authorities to rein in surging teenage pregnancies." So integration of life skills was brought into the teaching of mathematics pertaining to the topic of statistics. This data brought upon a demonstration of the significance of statistics in our daily encounters.

6.3.2 The background of the learner

Each of the learners being taught come from different backgrounds, but it is common that learners in a school have similarities, therefore it easy to detect the type of examples a teacher can use. The examples had to be what is familiar to them in order for effective teaching to occur. The background of the learners gave the participants an idea of the type of examples they can use, so that it is relevant and appropriate for the learners .When asked what guided the choice of examples to use in teaching statistics, Sam stated:

SI: "*… I think of the learner's background, community and socio economic status before using an example to make the learning applicable to the learners...*"

The appropriateness of the examples enhanced the teaching to ensure it is a success because statistics is taught through the process of using examples to deliver the content needed to be taught.

6.3.3 The gender of the learners

In the context of gender, learners are different and relate to certain contexts and situations differently. So when an example is used it has to accommodate both genders, for instance, in a class with boys and girls, a teacher should not use data pertaining to netball or a set of dresses. These types of examples disregard the male gender. When asked what guided him in his choice of examples to reiterate the teaching of statistics, Rodney responded:

RI: "*…since I teach boys only, I have to be guarded with the type of examples I use in my teaching…"*

According to Becker (1981) high school learners already have gender-role socialisation well established. Their behaviour may be a cause of the teachers' differential expectations and treatment of them with teacher behaviours being consistent with their expectations to reinforce societally prescribed gender roles rather than altering them to a more equitable view**.** Even when a teacher uses an example relating to cars, it tends to discriminate the female gender. The examples used by the participant should be applicable to both genders, ensuring that boredom does not set in and the learners remain interested in the lesson and are willing to learn. One of the participating schools was a boys' school, whereby it would have been irrelevant for the participant to use data pertaining to netball and dresses. It would have led the boys to lose interest in the teaching process as netball and dress sizes are irrelevant to them. Therefore, gender has a crucial role to play in the selection of examples used to teach statistics.

6.4 Changing the teaching method

It is common for participants to change their teaching methods for various reasons. Participants were confronted with varying situations at every school, having to work with what they are provided with to achieve the ultimate goal, which is teaching. The participants had to be aware of the different methods and adapt to being able to use them appropriately. The following reasons caused participants to change their methods when teaching different

topics in mathematics: the learners in the learning environment, the time frame allocated and the topic to be taught as well as classroom management.

6.4.1 The learners in the learning environment

The type of learners that a particular participant was faced with is different from other participants' learners especially at Grade 10 level where the participant is still assessing the type of learners with whom he or she is working**.** At this stage the participants were still trying to find the method that works and the level of understanding of the learners, together with the calibre of the learners with whom he or she was in contact. Furthermore, the participants' background and mathematical knowledge are also important and contribute to the choice of method. According to Stein and Ricket (1987) the structure of the mathematics curriculum is significant. Teaching the basics first is of paramount importance for the learners' understanding of mathematics. The ultimate aim of identifying a method is purely for the benefit of the learner. The learner is the focal point in the teaching process therefore the method is chosen to assist the learner to ensure understanding and appropriate learning takes place, which is done through effective teaching.

There are varying types of learners to deal with. There are certain learners who may have an influence in the classroom through a discipline process and other learners may have an impact through academic reasons. The number of learners per class affects the process because that situation is accompanied by negativity such as disruption and discipline problems in the process. Much peer pressure is displayed and distractions lead to poor results. According to Evertson, Emmer and Brophy (1980) when learners are focused it enables the teacher to feel less anxious and more confident to exhibit more enthusiasm. The method that each participant decided to use had to accommodate all sets of learners, to ensure there was a balance in order for consistent and quality learning to take place.

6.4.2 The timeframe allocated and the topic to be taught

Time is a crucial factor in any teaching process and within the teaching of mathematics; a teacher is allocated a certain amount of time to teach a particular topic. These topics all require certain concepts to be taught and understood for the outcomes of that topic to be achieved. Not many of the learners are at the level of understanding of what they ought to be at Grade 10 level. This required the participants to revise concepts that are expected to have

been taught in previous grades. CAPS is clear about revising work done in previous grades and consequently the participants had to teach these concepts first otherwise the learning will be unsuccessful and the teaching will be meaningless. With Grade 10 -12 learners being encouraged to write the common tests papers, the participants had to select a method that will accommodate for remedial work and present work to be taught, since mathematics is a process of progression from one grade to the next. It is noted that time and the topic work in conjunction with each other. From my observations, it has been clear that the more complex the topic the more time is needed, therefore the method is influenced by the time allocated for the topic and the complexity of the topic to be taught. Participants were compelled to choose a method which will fit in with the time allocated to complete the topic.

The complexity of the topic required the participant to utilise a method that simplified the concepts to allow for understanding to take place. Therefore the participants were creative to ensure the method used allowed for successful teaching to occur. Each participant approaches and understands a topic differently. Therefore their method of teaching always differed from the next as every individual participant had a preferred and specified method for each topic. When a participant plans a lesson, he or she looks at a variety of factors. Teachers have a very close link to the method together with the intensity of the topic in determining the choice of method in conjunction with the type and calibre of the learners being taught.

Each topic has its own complexity and within this study the focus is more on the topic of statistics where one may find that many participants claim that statistics is easier to teach and understand with the concepts being easily grasped. This allows the participant to become more flexible in terms of the choice of method, which is the reason that most participants used casual and relaxed methods such as discussions, brainstorming and presentations that explore the topic in detail and the participant decides on the most suitable and appropriate teaching method.

6.4.3 Classroom Management

Classroom management is the first step before any teaching can occur. Walshaw (2004) suggests practices of discipline are practices for the formation of a classroom teacher. With the new legislation that teachers need to abide by, maintaining classroom management has become a challenge in many schools, especially with the abolishment of corporal punishment. The participants have to identify methods that will integrate classroom management and

effective teaching simultaneously. According to Evertson, Emmer and Brophy (1980) more effective teachers have less discipline issues and learners behave more appropriately. Killen (2000) adds that successful task orientation is primarily a matter of classroom management. One of the participants indicated that the use of a worksheet as an instructional tool increased participation and discouraged misconduct by appointing the disruptive learners to read. Sam in the interview responded by saying:

SI: "…*in the lesson I make the disruptive learners read the worksheet, I prepare keeping in mind the disruptive learners to ensure good classroom management is maintained and their attention in the learning process…"*

One of the participants claimed that making use of a textbook as an instructional tool kept the learners constantly working and made it easier to monitor their behaviour, ensuring discipline was maintained. Another participant also indicated that the use of the chalkboard as an instructional tool was a way to ensure discipline is maintained to ensure the learners are continuously writing and kept busy.

RI: "…*my main reason for using a chalkboard is that learners must engage in the lesson by writing, they tend to remember and learning takes place continuously…"*

Every participant, before going to the classroom, does some form of preparation in order to be adequately prepared, giving the teacher the required confidence. Asikainen, Pehkonen and Hirvonen (2013) explain that the quality of an individual teacher's own knowledge is related to the preparation of lessons, teaching and delivery of these lessons. Furthermore Krauss, Baumert and Blum (2008) claim a teacher's content knowledge influences the process of teaching within a mathematics classroom.

In order for the participant to choose a particular teaching method, preparation has to be the central point. The choice in the teaching method a teacher chooses is dependent on the class and the calibre of learners. When preparing the lesson, all the factors come in to play in order for the participant to decide on the method which best fits that particular lesson and class. A topic like statistics is closely aligned to teaching methods such as brainstorming, discussion, demonstration, lecture or presentation and independent study. These teaching methods require good classroom management in order for the aim of the lesson to be achieved. Within

a lesson where the topic statistics is taught there exists a lot of discussions to elaborate on concepts, the exchange of ideas and debate on the arrival at a particular conclusion. Demonstration on the content in relation to the scenario leads to presentations and independent study. Whereby the learners relate their learning to situations they are confronted with in their daily encounters. Hence, the topic at hand incorporates a lot of activity within the lesson.

After having put much effort in the choice of method, it is clear that preparation before the lesson is done. Without preparation, the participant will be unsure which method and instructional tool to use and how to use the suitable teaching method in conjunction with the instructional tool to accommodate the class at hand.

6.4.4 The teaching environment

The teaching environment is not in isolation but integrated with the learners' background and socio economic status. These three elements are integrated as they cannot be isolated. If the school is under privileged so are the learners, their background and economic situations. These factors lead to many challenges and obstacles in the teaching process. Obstacles have an impact on the teaching and the choice of teaching method to use in accommodating such a situation. Even when the school is a privileged school and the learners come from more affluent backgrounds, their socio economic status differs. Once again the method and process of teaching is completely opposite. According to Walshaw (2004) it is the role of the teacher to supply work and activities to enable practice of mathematical skills and ideas. Each method and instructional tool chosen by a participant depends on the environment and calibre of learners a participant is teaching.

The situation with which a participant is faced pertaining to the school and more precisely the Grade 10 mathematics classroom is determined by the resources that were available to the participant, the location of the school and the economic status of the learners. This has an influence as the participant has a limited choice in the instructional tool to use due to a shortage of resources and other factors such as space, infrastructure and the schools' functional system. This made the teaching process more complicated as the participant may have been limited with resources and restricted to one particular method and instructional tool. These complications had a huge impact on the teaching, and subsequently there are times when the school and the learners are a challenge. The teaching became cumbersome as

the type of examples and the method one used needed to accommodate the situation at hand. According to Hooper and Rieber (1995) the teacher's function is to create a learning environment that supports and facilitates learners when they construct and shape their own knowledge. However, in some schools, the participants were innovative and used methods that actually target maximum learning. It is expected that when learners have adequate resources, they are more likely to excel academically.

Therefore a situation and atmosphere of this nature is completely different to the former, the majority of other participants were confronted with situations where both these challenges and privileges existed in their schools and classrooms. These participants were forced at times to work with only what they have, which has its advantages and disadvantages. According to Walshaw (2004, p.74) "power, knowledge and truth become coordinates that constitute relationships in the classroom". Despite the challenges, obstacles and privileges, the participant still had to be creative and able to work with the situation with which they were presented as the ultimate goal of being in the classroom situation was to teach using a method most appropriate to the time and environment.

The participants voiced their support in the use of the methods by unpacking the reasons as to why they used particular methods in the teaching of statistics. This was achieved through the semi- structured interviews, where participants elaborated on the use of their methods, provided reasons for their choice of methods, experiences, challenges and suggestions on how to overcome these challenges. The findings that emerged from the semi-structured interviews with participants were: all seven participants preferred the use of the chalkboard as an effective instructional tool in teaching statistics, which was used to emphasise the concepts and calculations. The chalkboard was used to emphasise concepts and used for reiteration as stated by participants when asked why they used the chalkboard in their teaching:

BI: *"…depending on the content for the lesson with a follow up lesson, I will use the chalkboard to emphasise the concepts…"*

SI: *"… the chalkboard is used to emphasise concepts and provide worked solutions…"*

NI: *"… the chalkboard and textbooks work well for me because the numbers and data are already in the textbook. So I do the application, the methods and workings on the chalkboard…"*

RI: *"…even using the textbook and worksheet you still need to reiterate or explain on the board, so why not use the board throughout. My main reason for using a chalkboard is that learners must engage in the lesson by writing, they tend to remember and learning takes place continuously…"*

ZI: *"…The basic chalk and talk method which is the traditional method, I also rely heavily on my chalkboard finding it the most effective method, being aware there are many new resources out there…"*

Although the participants used other teaching methods and instructional tools, they still resorted to the chalkboard because it was at their disposal and was the centre of attention. Taking into account that the chalkboard is one of the more popular instructional tools used, participants found it fitting to also use it when they taught. Therefore, the participants retained it and found it useful since it was effective in their learning**.** All the seven participants in the study indicated that every topic was associated with a particular method and instructional tool because every topic is different, yet still made use of the chalkboard to reiterate and emphasise concepts. The choice of method was highly dependent on the topic and concept to be taught. So it was clear that the participants changed their methods depending on the topic**:**

BI: *"… I change methods according to the content being taught..."*

SI: *"… You cannot use one method; you are guided by the different topics in the methodology to use through your lesson preparation…"*

PI: *"…Change the methods when I teach mathematics depending on the topic..."*

It was not only the topic that hampered the choice of method; there exists other factors that have an influence in the choice of methods. The factors which many participants mentioned were: the caliber of learners, resources in the school and the time that was allocated to teach the topic within the work schedule. Time plays a crucial role in the choice of method to be used when teaching a particular topic.

6.5 The participants' perceptions of the topic statistics

Participants have different perceptions of statistics yet have a common understanding of the topic. The participants viewed statistics as crucial for the career paths of learners. Learners would use statistics in the choice of their careers because they compare, analyse and make

decisions. The participants were of the view that statistics would assist learners in decision making as they are able to compare all the options available to them. It is part of learning as it teaches them life decisions. According to Batanero, Burril and Reading (2011) being statistically literate allows one to use statistics in the workplace, personal life and as citizens. Learning statistics at an early age equips them for the future as in life statistics is used on a daily basis when comparing, analysing and making decisions.

BI: "… *statistics is vital as almost everything we do revolves around statistics*…"

Similarly, Rumsey (2002) noted that the introduction of statistics into the school mathematics curriculum was to raise awareness of the data in everyday life in order to prepare learners for the current situations they face. Participants made the following statements pertaining to their perceptions of the topic statistics being part of the mathematics curriculum.

BI: "… *Statistics plays a major role within the curriculum and cannot be by passed or neglected…"*

ZI: "*... an important topic to be taught at school level, part of what we teach is to teach learners to make proper decisions and decisions of life*…"

PI: "…*we apply mathematical concepts in everyday life and simple examples of how many cars pass a toll gate for traffic control…*"

MI: "…*It's essential that learners learn how to analyse, compare and conclude at school level in preparation for when they leave school…*"

RI: "…*ensure learners understand statistics when it is presented to them because in the real world we come across a lot of statistical reports…*"

The participants were of the following views pertaining to the statistics topic:

PI*: "... if statistics is learnt at an early stage it becomes part of their lives..."*

SI: *"...it creates thinking amongst the learners so that they become critical thinkers by having the ability to be analytical…"*

NI: *"...it is equips learners for the outside world. Statistics empowers learners to be able to make decisions and draw conclusions and more precisely become statistically literate since we live in a data driven world…"*

6.6 Recommendations

Based on the findings of this study the following recommendations are made:

6.6.1 Recommendations to teachers

It is advisable for teachers to familiarise themselves with the current CAPS policy documents and learning programmes when planning their lessons to improve their teaching. Lesson planning according to the current CAPS policy document is an important aspect of teaching before going to teach a class. Teachers who are teaching Grade 10 should work with their neighbouring schools with the aim of developing appropriate preparatory materials that will enable their learners to make sense of mathematics. Tasks that will give learners opportunities to investigate, analyse, explain and justify their thinking should be created, especially with a topic like statistics.

Teachers can seek innovative ways of teaching that could present a variety of responses from learners. This could be possible by considering the social surroundings and backgrounds from which learners come in order to inculcate meaningful learning. Teachers could develop a wide variety of examples related to mathematics by considering the learners' cultures and lifestyle. Teachers should work towards helping learners develop a positive attitude to mathematics by engaging them in critical thinking using real world examples to relate to the content. Teachers can make use of available teaching resources from their schools that can be developed as supplements to textbooks like charts and work sheets.

6.6.2 Recommendations to School Management Teams (SMTs)

Schools ought to organise regular school based workshops to support teachers in current teaching approaches and in assessment strategies to ensure content development is maintained amongst newly appointed and inexperienced teachers. The schools can invite subject specialists of the different topics to workshop teachers especially the newly introduced topics which are unfamiliar to the teacher to assist in the providing of information on how to teach the learners in attempting examination type questions and different ways they could be tested.

Heads of Departments (HODs) can have systems in place to monitor and develop teachers with regard to their teaching and assessment in mathematics in order to monitor and manage the curriculum implementation in their schools. The schools could involve teachers when ordering Learner Teacher Support Material (LTSM) with the aim of improving the quality of

teaching of mathematics within the school. The use of a single textbook by teachers and the learners as a resource may seem adequate and feasible. But it does not cover all the aspects of the topic in the curriculum requirement specified by the CAPS document. The Department of Education has recommended one textbook per learner and per subject. The teachers have utilised worksheets and other instructional tools. Due to one resource not covering the entire content specified by the CAPS document. Not ignoring the fact that these textbooks are CAPS approved. Hence, the teachers provide additional worksheets and other instructional tools from a variety of resources such as the internet, other textbooks, past papers and study guides. One textbook may not provide a variety of examples to accommodate all the learners, therefore additional resources may benefit the teaching of the topic and subject.

6.6.3 Recommendations based on the findings

Mathematics teachers ought to be invited for regular workshops which focus on improving and promoting statistics content and statistics pedagogical knowledge. The workshops should focus more on statistics content knowledge as the majority of the participants in the study claimed that they were not taught statistics at tertiary level. Similarly, according to Lemmer, Edwards and Rapule (2008), many serving mathematics teachers did not study statistics during their pre-service training. Simon (1994) also feels that teacher development is essential in the teaching and learning of mathematics, where teachers are constantly empowered and kept up to date with current teaching methods including content knowledge.

It is important to underline that all the participants in the study are teaching the same topic, yet using different methods to teach statistics within the same grade. Taking into account that the learners learn differently which presents the opportunity and necessity. Teachers need to continuously go on workshops to be made aware of the different methods that can be used in the teaching of statistics. Empowerment is crucial considering that majority of teachers have very little training in the topic of statistics. Nevertheless they were able to deliver the content prescribed for the particular lesson and grade. Empowerment pertaining to content is vital in the teaching and learning. The empowerment of teachers in the content knowledge leads to quality teaching. The examples participants used can be improved by using examples that educate the learners for the present and future. By not focusing only on what relates to them presently, but what can be of benefit to them in the future.

I suggest that in-service teacher training programmes should be comprehensive enough, thus allowing for thorough coverage of the content if they are to be beneficial to teachers. According to Batenero, Burrill and Reading (2011) a teacher's mathematical knowledge plays a crucial role in the quality of teaching. I also suggest that in-service workshop trainers may consider the results of this study when conducting workshops. According to Owusu-Mensah (2008) self-evaluation methods in identifying the needs, strengths and weaknesses of a teacher and classroom observations should be utilised to determine further in-service needs of teachers. Subject advisors are requested to visit schools on a regular basis, with the aim of developing and supporting teachers in curriculum implementation, since the curriculum changes on an on-going basis. The South African mathematics curriculum has changed several times in conjunction with the change of government.Textbooks which are approved by the Department of Education should be well written, to provide explicit explanations and be comprehensive on the topic of statistics. Textbook authors or writers should ensure that learner activities are challenging and contribute to the learning of the content. This could assist in ensuring the teaching of statistics is clear and easy flowing to teach. Burgess (2008) points out that statistics is young within the mathematics curriculum and some teachers who are least experienced consider the textbook as being accurate and tend to follow it as opposed to the policy document, with the Department of Basic Education insisting that each learner should be in possession of a textbook for each subject.

6.7 Conclusion

This chapter provided a summary of the findings and recommendations. The study aimed at exploring the teaching of statistics at Grade 10 level. The current mathematics curriculum in the FET band was developed with the aim of promoting learners who were able to collect, analyse, organise and critically evaluate information (DOE, 2012).

This suggests that teachers may need to adjust their teaching methods to accommodate for this new aim. The current teaching methods require teachers to demonstrate skilful practices in facilitating meaningful learning. Therefore there is a need to equip teachers with adequate skills that will deepen their content knowledge with regard to teaching mathematics. On-going professional support from the Department of Education officials is the most needed priority for supporting teachers to engage in the teaching of mathematics. This professional support includes organising of workshops, providing adequate teaching resources and improving classroom infrastructure for the teaching and improvement of mathematics.

CHAPTER 7
CONCLUSION

7.1 Introduction

The study presented in this thesis explored the teaching of statistics and the methods and instructional tools that are associated with the teaching of mathematics at Grade 10 level. The study took place at seven different secondary schools in KwaZulu-Natal within the Durban South Region. The study was motivated by an invitation I was given to attend a Maths 4 Stats workshop at the University of KwaZulu-Natal in 2011. It indicated that there was a steady increase in the awareness of the importance of statistics and the teachers need for content knowledge pertaining to the topic of statistics. Most teachers who obtained their pre-service training from colleges could not teach statistics as it was not part of the curriculum at these colleges. Thus, according to Makwakwa and Mogari (2012) there was a significant number of teachers who were confronted with statistics for the first time when it became part of school mathematics in the FET band for the first time in 2006.

In addition, there have been numerous other in-service training workshops aimed at providing teachers with the required content knowledge and skills to teach statistics initiated mainly by non-governmental and governmental organisations such as Statistics South Africa (Stats SA), Department of Basic Education and the Association for Mathematics Education of South Africa (AMESA). According to North and Zewotir (2006), in-service workshops on statistics provide teachers with the opportunity to increase their knowledge so that they can teach statistics to learners who will soon exit school.

The research questions were:

1. What methods do teachers use when teaching statistics in Grade 10?
2. How is statistics taught in Grade 10?
3. Why are these methods being used by teachers when teaching statistics in Grade 10?

In this chapter, firstly I summarised the key findings in the study. Secondly, I decided upon the methodological approach I used in the study. Thirdly, I highlighted some of the implications of the study for the teaching of mathematics. Finally, I discussed some of the limitations of the study.

7.2 Key findings of the study

The findings of the study indicate that the teacher's decision in choosing the method to teach statistics is dependent on a number of factors for example the calibre of learners, school infrastructure, the gender of learners, their race group and their cultural backgrounds. Participants' responses indicate how teachers experienced the teaching of mathematics in their classrooms through a system of social, cultural and interpersonal processes. Participants indicated that these experiences had an impact on their decisions in the choice of method and instructional tools to be used in their teaching. The participants seemed to face a variety of challenges: the participants found challenges to deal with a large number of learners in their classes, making it difficult to provide individual attention that mathematics learners require. The participants expressed that learner morale in mathematics is consistently low and that learners displayed a negative attitude towards mathematics. Furthermore, they discovered that there was continuous curriculum change with little direction given.

A number of factors seem to be associated with the choice of method and instruction tool. All seven participants stated that they made use of the chalkboard as an instructional tool. The chalkboard was convenient to use in their teaching as they found merit in the chalkboard to reiterate and emphasise the concept to be taught. The entire sample of participants had more than three years of teaching experience and they all agreed that teaching experience contributed to the teaching of mathematics. The participants expressed that both they and the learners enjoyed the topic of statistics, although they expressed their concern over the empowerment of the content within the topic. One of the findings was that gender and race did emerge as a significant issue in the type of examples that teachers used to emphasise the content in conjunction with the concept. This finding is interesting in view of the fact that statistics is related to real life experiences and real life examples are used to reinforce the content within the mathematics classroom, in order for the teaching to be realistic and meaningful to learners.

The study revealed that most teachers enjoyed teaching statistics and used creative methods and examples to reiterate their teaching. They alluded to the fact that statistics as a topic at Grade 10 level within the mathematics curriculum was exciting and meaningful and learners seldom struggled with understanding and making sense of the content taught in statistics. Participants across the different schools stated that the teaching of statistics was exciting and

informative within the world we live, since we are currently living in a data associated world and a society driven by data.

7.3 Methodological approach

The study focused on exploring the teaching of statistics at Grade 10 level, where participants' views, actions and opinions were considered within the study. It was expressed by participants that the topic of statistics in the mathematics curriculum is new and unfamiliar to many teachers. The classroom settings were evidence of this as only one classroom amongst all the seven had a statistics chart on the wall. The participant notified me that he only put up the chart with concepts pertaining to statistics after having a look at the observation schedule. Statistics (Data handling) is in the curriculum to reinforce the changing world we live in and the changes in education. It is in the school curriculum to help create statistically literate individuals for the future.

A qualitative method was used and enabled a better understanding of the aims of the research. According to Flick (2009, p.12) "qualitative research is of specific relevance to the study of social relations". The topic of this study deals with concepts pertaining to real life experiences and encounters. Furthermore, according to Cresswell (2012), qualitative researchers usually identify cases that are part of everyday life and usually focus on human factors. Similarly, Duemer and Sanderson (2008) view qualitative research as an activity that situates the researcher in the context which is being studied.

Within this study, the school environment was the central point and field for the study and provided value towards the study. It provided the study with credibility whereby the researcher became part of the study and had a personal engagement with it. Kuper, Reeves and Levinson (2008) describe qualitative research as a research methodology that enables valuable data and the exploration of real world behaviour which allows the participants to express themselves verbally and through their actions.

In this study, this was possible through the observations and semi - structured interviews that took place. Oliver-Hoyo and Alleen (2006) describe the importance of qualitative research as the process of investigation leading to certain results that the researcher wished to achieve. The qualitative research method, according to Cohen, Manion and Morrison (2011), allows for data to be descriptive which is collecting verbal responses and the observation of

behaviour. In this study, the researcher explored the teaching of statistics at secondary school level, focusing specifically at Grade 10 level.

Through observing teachers teaching statistics at Grade 10 level, the researcher thereafter conducted semi-structured interviews pertaining to the observations. Oliver- Hoyo and Alleen (2006) claim that qualitative research is work done in order to understand what is socially constructed by individuals, by engaging with the context in which they interact. Therefore, in this study the researcher interacted with mathematics teachers from the different schools who facilitated the teaching of statistics within the Grade 10 mathematics classrooms. These mathematics teachers are responsible for the delivery and implementation of the curriculum to the learners. Participants were knowledgeable regarding the curriculum as they delivered the content prescribed by CAPS to the learners.

Bashir, Afzal and Azeem (2008) concur that it is common that a qualitative researcher is physically present at the research site to engage more closely with the participants. The researcher aimed to gather and receive full value in the critical research questions of the study. According to De Vos (2002) in a qualitative research method the researcher is directly involved in the study. Therefore, within this study, the researcher used three instruments which were the questionnaires, observations and the semi-structured interviews which allowed the researcher to be fully involved in the study throughout the research process.

7.4 Implications of the study

The study has implications for the teaching of mathematics with a particular focus on the topic of statistics and for future research on the topic. It draws attention to the teacher and the teaching practices, which are, the methods, instructional tools and examples teachers use in the classrooms which can impact learners' experiences and attitudes towards mathematics and the topic of statistics. However, it must be made clear that identifying and adopting teaching methods that suit all learners is a challenge for teachers. Many participants testified to the fact that mathematics at secondary school level seemed to the learners, to be boring and difficult. I also agree to the former from my personal experience of teaching mathematics, interactions with other mathematics teachers and informal discussions and according to Lee and Ginsburg (2009) it is commonly agreed that the majority of learners find mathematics difficult and irrelevant to their lives. It is then no secret that teaching mathematics in schools has been a challenge to most teachers, as evidenced by the low pass rate for the past few

years. According to Khuzwayo (2005) there has been a scarcity of qualified mathematics teachers which led to poor performance by learners and a general lack of interest in the subject. Within this study the participants were all qualified mathematics teachers with a minimum of 3 years teaching experience. With this in mind teachers were able to teach the topic statistics effectively. In this study the focus was placed on the topic of statistics at grade 10 level. Mathematics has a number of topics and taking into account that statistics in South African only contributes 14- 18% of the mathematics curriculum in Grade 10, which forms part of the Grade 10 -12 band (DoBE,2011).

Therefore, statistics is of a more interesting aspect when it comes to mathematics at secondary school level. The study points to the need for a focus on making mathematics meaningful and real as this could be the key to motivate learners. In order to address the strong negative emotions that mathematics classes seem to cultivate in learners, the use of real life examples could possibly eradicate such perceptions and feelings.

Professional teacher education programmes and workshops need to develop practices that examine the diverse needs and attitudes of learners by improving mathematical content knowledge and pedagogical knowledge. Allowance should be made for the development of classrooms that are exciting environments and where the emphasis is on understanding and meaningful learning. The findings suggest that an area for future research is the development of a more variety of teaching methods and a variety of instructional tools in the mathematics classroom and variation of examples to be used in order to improve mathematics achievement in the learners. The examples used need to be realistic, meaningful and relevant to the learners.

7.5 Limitations of the study

It is not certain that all teachers teaching Grade 10 mathematics especially in the Durban South Region have the reasoning ability as those who participated in this study. Furthermore, as the researcher is a mathematics teacher, bias and subjectivity could have affected the teacher interviews, such as the asking of leading questions. According to Maree (2007) the researcher has the ability to use relevant prompts and probes to allow the teachers to explain, clarify and elaborate, producing rich and first-hand information.

This is one of the shortcomings experienced in the interview process. In certain instances, the semi-structured interview took on a question and answer format. The researcher could have pursued the responses to the questions further in order to acquire sufficient data. According to Cohen, Manion and Morrison (2011) the sample size should be large enough to generate sample data. The sample used in this study was small and that was the main limitation that impacts on the generalisation of the data. Another limitation was that the schools, where participants teach, were situated in urban areas only.

The limitations of this study were also that the teachers did not have enough time to be observed based on the number of classes they teach per day. The negotiation of time to observe the teachers was an obstacle as the time on the work schedule to teach statistics is short and limited at Grade 10 level. Furthermore, statistics was taught in the third term according to the mathematics work schedule followed in the Durban South Region at the time the observations were due to take place. Time constraints and pressure on the teachers who participated were further compounded due to matric trial examinations.

7.6 Conclusion

The intention of this study was to make a meaningful contribution to the body of knowledge related to the teaching of mathematics in the FET phase and more precisely at Grade 10 level on the topic of statistics. During the semi- structured interviews some of the teachers expressed excitement and motivation towards the topic of statistics because they felt competent in dealing with it although they had very little or no training in the topic. Statistics is an important component for many careers such as economics, management, social sciences business, medicine, engineering, mathematics etc. Recent curriculum changes such as CAPS in South Africa demonstrate a strong belief in the topic statistics. For the curriculum reform initiatives to be successful there needs to be an in depth look at teacher education courses at both levels of pre-service and in-service. Not all the teachers who participated in this study obtained training in statistics at tertiary level. Therefore this study focused primarily on the teaching of statistics at Grade 10 level, which required an in-depth exploration on the methods, examples and reasoning of these methods used in order to obtain understanding and meaningful learning in the teaching of statistics at Grade 10 level.

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Appendix 1

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,

Dear Participant

INFORMED CONSENT LETTER

My name is Romano Taylor I am a master's candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in exploring the teaching of statistics at grade 10 level. To gather the information, I am interested in asking you some questions.
Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The interview may last for about 45 minutes to 1 hour.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

I can be contacted at:

Email: romanotaylor99@yahoo.com or 206505102@stu.ukzn.ac.za

Cell: 082 733 0537

My supervisor is Dr. Jayaluxmi Naidoo who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)
Tel: 031 260 3587
Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I…… (full names and surname of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT **DATE**

…… **……**

SIGNATURE OF PARENT (If participant is a minor) **DATE**

…… **……..**

Appendix 2

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,

The principal/ governing body

INFORMED CONSENT LETTER

My name is Romano Taylor I am a master's candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in exploring the teaching of statistics at grade 10 level. To gather the information, I am interested in asking mathematics teachers at your school some questions.
Please note that:

- Their confidentiality is guaranteed as their inputs will not be attributed to them in person, but reported only as a population member opinion.
- The interview may last for about 45 minutes to 1 hour.
- Any information given by the teachers cannot be used against them, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- Teachers have a choice to participate, not participate or stop participating in the research. They will not be penalized for taking such an action.
- Teachers' involvement is purely for academic purposes only, and there are no financial benefits involved.

I can be contacted at:

Email: romanotaylor99@yahoo.com or 206505102@stu.ukzn.ac.za

Cell: 082 733 0537

My supervisor is Dr. Jayaluxmi Naidoo who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)
Tel: 031 260 3587
Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I…… (full names and surname of principal) hereby confirm that I understand the contents of this document and the nature of the research project, and I give consent to mathematics teachers at my school participating in this research project.

I understand that the teachers are at liberty to withdraw from the project at any time, should they so desire.

SIGNATURE OF PRINCIPAL **DATE**

…… **……**

SIGNATURE OF PARENT (If participant is a minor) **DATE**

…… **……..**

Appendix 3

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,

Dear Parent/ Guardian and Learner

INFORMED CONSENT LETTER

My name is Romano Taylor I am a master's candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in exploring the teaching of statistics at grade 10 level. To gather the information, I am interested in asking mathematics teachers at your child/wards school some questions.
Please note that:

- Your child/wards confidentiality is guaranteed as their inputs will not be attributed to them in person, but reported only as a population member opinion.
- Any information given by your child/ward cannot be used against them, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- They have a choice to participate, not participate or stop participating in the research. They will not be penalized for taking such an action.
- Their involvement is purely for academic purposes only, and there are no financial benefits involved.

I can be contacted at:

Email: romanotaylor99@yahoo.com

206505102@stu.ukzn.ac.za

Cell: 082 733 0537

My supervisor is Dr. Jayaluxmi Naidoo who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

You may also contact the Research Office through:
Ms P Ximba (HSSREC Research Office)
Tel: 031 260 3587
Email: ximbap@ukzn.ac.za)

Thank you for your contribution to this research.

DECLARATION

I…… (full names of parent/guardian) of …… In grade 10 ……., hereby confirm that I understand the contents of this document and the nature of the research project, and I give consent to my child/ward participating in the observation of the research project.

I understand that the teacher involved is at liberty to withdraw from the project at any time, should they so desire.

SIGNATURE OF LEARNER **DATE**

…… **……**

SIGNATURE OF PARENT / GUARDAN (If participant is a minor) **DATE**

…… **……..**

Appendix 4

QUESTIONNAIRE FOR THE GRADE 10 MATHEMATICS TEACHER

Code: …….. **Date……**

Please respond to the following questions by indicating with a ***cross*** inside the square next to the option that applies to you, where possible please explain the reason for your answer

1. Please indicate your gender:
   - male ☐
   - female ☐
2. Please indicate your race group:
   - African ☐
   - Coloured ☐
   - Asian ☐
   - White ☐
   - Other ☐

   If other, please specify:

   ……
3. Teacher qualification in mathematics:
   - B.Ed. maths ☐
   - B.Ed. and Honours maths ☐
   - B.Ed., Honours and M.Ed. ☐
   - Other ☐

   If other, please specify:

   ……
4. Please indicate if you presently teaching FET (Further Education and Training) mathematics:
   - Yes ☐
   - No ☐

5. Please indicate the grade you are currently teaching in mathematics at FET level:

- Grade 10 □
- Grade 11 □
- Grade 12 □

6. Please indicate the number of years you are teaching FET mathematics:

- 0 – 5 □
- 6-10 □
- 11-20 □
- 20 plus □

7. Please indicate number the of years you are teaching statistics (FET) :

- 0-5 □
- 6-10 □

8. Do you have any training and professional development in Statistics education in mathematics education?

Please specify:

……
……
……

9. What instructional tool are you currently using to teach statistics?

- Textbook □
- OHP □

- PowerPoint ☐
- Chalkboard ☐
- Worksheets ☐
- Other ☐

If other, please specify:

……..

10. Which teaching method do you use to teach statistics in mathematics?

- Lecture ☐
- Class discussion ☐
- Presentations ☐
- Problem solving ☐
- Use of chalkboard ☐
- Worksheets ☐
- Oral reports ☐
- Other ☐

If other, please specify:

……
……

THANK YOU FOR YOUR TIME IN COMPLETING THIS QUESTIONAIRE ☻

Appendix 5

OBSERVATION SCHEDULE FOR GRADE 10 MATHEMATICS LESSON

Teacher: ……..... **Date**……..

Topic of the lesson: …… **Duration of Mathematics lesson**……..

Time observation started: ……. **Time observation ended:** …….

The researcher will make note of the following and transcribe the observation verbatim

1. **CLASSROOM (learning environment)**

The classroom environment, infrastructure and it's conduciveness for the subject.

Noting the number of desks for the class size, posters which enhance the topic, role of learners in the classroom and number of girls and boys to examine the examples used.

2. THE INTRODUCTION OF THE LESSON

How does the teacher draw the attention of the learners?

What methods are being used to introduce the lesson?

What examples are being used to introduce the topic?

The teacher's response to the learners' responses

3. **THE DEVELOPMENT AND STRUCTURE OF THE LESSON**

How does the teacher unpack the topic statistics?

What methods does the teacher use to teach and unpack the topic?

How does the teacher use these methods to teach the topic?

What examples does the teacher use to teach the topic for the learners to relate to the topic?

4. **CONCLUSION OF THE LESSON**

How does the teacher consolidate and conclude the lesson?

Appendix 6

SEMI- STRUCTURED INTERVIEW FOR THE GRADE 10 MATHEMATICS TEACHER

Time: 30 -45 minutes **Date**: …….

Code: ……

Interview Questions

1. Which method did you find most appropriate for teaching the topic statistics in mathematics and why?

2. Do you perhaps change methodologies according to topics in the mathematics curriculum?

3. How do you decide on the teaching method to use when you teach statistics in mathematics?

4. What are the factors that guide you in the selection of the method to use when teaching statistics in mathematics?

Appendix 7

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Sibusiso Alwar Tel: 033 341 8610 Ref: 2/4/8/61

Mr RGS Taylor
54 Narbada Road
Merebank
4052

Dear Mr Taylor

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"Exploring the teaching of measures of central tendency in Grade 10 statistics"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 February to 30 June 2014.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mr. Alwar at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Director-Resources Planning, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 07 March 2014

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu Natal, Republic of South Africa ...dedicated to service and performance
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel: 033 392 1004 Fax: 033 392 1203
EMAIL ADDRESS: kehcloglo.connie@kzndoe.gov.za; CALL CENTRE: 0860 596 363;
WEBSITE: www.kzneducation.gov.za

Appendix 8

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Nomangisi Ngubane Tel: 033 392 1004 Ref.:2/4/8/61

Mr RGS Taylor
54 Narbada Road
MEREBANK
4052

Dear Mr Taylor

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"EXPLORING THE TEACHING OF STATISTICS IN GRADE 10"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 June 2014 to 30 May 2015.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 21 October 2014

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel. 033 392 1004
EMAIL ADDRESS: kehologile.connie@kzndoe.gov.za / Nomangisi.Ngubane@kzndoe.gov.za
CALL CENTRE: 0860 596 363; Fax: 033 392 1203 WEBSITE: WWW.kzneducation.gov.za

Appendix 9

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Sibusiso Alwar | Tel: 033 341 8610 | Ref.:2/4/8/61

Mr RGS Taylor
54 Narbada Road
Merebank
4052

Dear Mr RGS Taylor

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"Exploring the teaching of measures of central tendency in Grade 10 statistics"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 June 2014 to 30 May 2015.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mr. Alwar at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Director-Resources Planning, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 09 June 2014

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa ...dedicated to service and performance
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel. 033 392 1004 Fax: 033 392 1203
EMAIL ADDRESS: kehologile.connie@kzndoe.gov.za; CALL CENTRE: 0860 596 363;
WEBSITE: WWW.kzneducation.gov.za

Appendix 10

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

23 June 2014

Mr Romano Taylor (206505102)
School of Education
Edgewood Campus

Protocol reference number: HSS/1193/013M
Project Title: Exploring the teaching of measures of central tendency in Grade 10 statistics

Dear Mr Taylor,

Full Approval – Expedited Application

With regards to your response to our letter dated 11 December 2013, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Dr Shenuka Singh (Chair)

/ms

cc Supervisor: Dr J Naidoo
cc Academic Leader: Professor P Morojele
cc School Admin: Mr Thabo Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 Facsimile: +27 (0) 31 260 4609 Email: xmbanc@ukzn.ac.za / snxmanpw@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

Appendix 11

Angela Bryan & Associates

6 La Vigna
Plantations
47 Shongweni Road
Hillcrest

Date: 23 May 2016

To whom it may concern

This is to certify that the Masters Thesis: Exploring the teaching of statistics in Grade 10 written by Romano Taylor has been edited by me for language.

Please contact me should you require any further information.

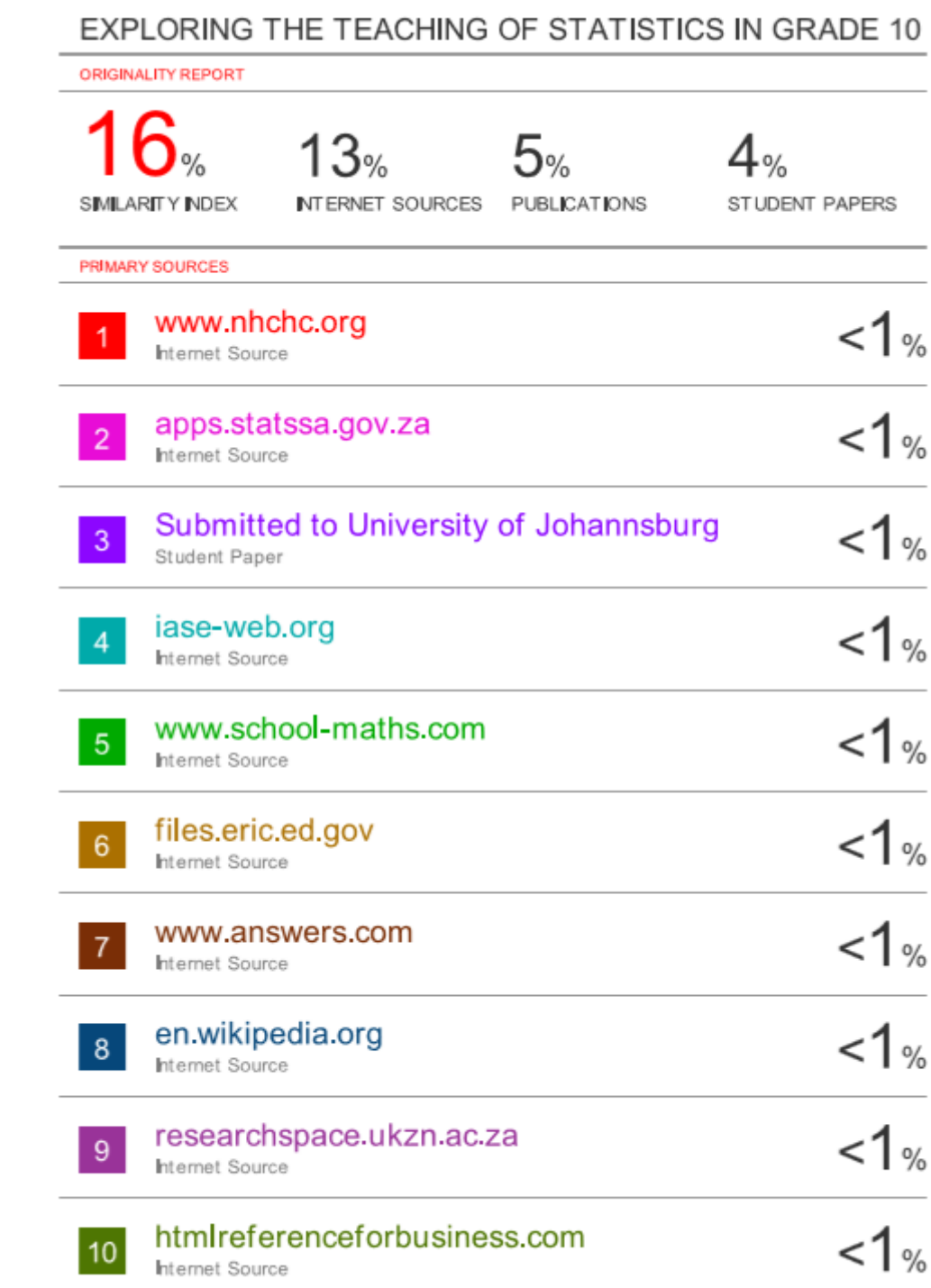
Kind Regards

Angela Bryan

angelakirbybryan@gmail.com

0832983312

Appendix 12



EXPLORING THE TEACHING OF STATISTICS IN GRADE 10

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